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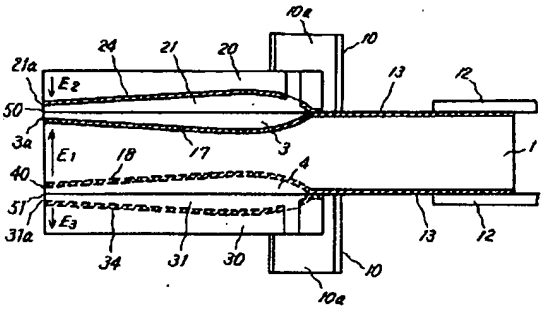
(54)【発明の名称】　インクジェット記録ヘッド

(57)【要約】
【目的】　ノズルプレートの取り付けを不要として製造工程の簡素化を図りつつ安定したドットを形成させること。
【構成】　分極方向を対向させて形成した２枚の圧電体１、２０及び１、３０からなる基板の境界を跨ぐように、一端が大気に開放され、かつインク滴を飛翔させるのに適した開口５０、５１を備えた溝３、２１、４、３１を一定ピッチで形成し、これら空洞の内面に電極１７、２４、１８、３４を形成しておく。インク滴を形成すべき領域の溝、及びこれの両隣の溝の電極とにそれぞれ異なる極性の電圧を印加すると、溝を隔てている隔壁がインク滴を形成すべき溝側に剪断変形する。この結果、インク滴を形成すべき溝の容積が縮小されて、ここに存在するインクが開口から外部に飛翔することになる。



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【特許請求の範囲】

【請求項1】　インク溜め部を形成する深度を備える部分と、一側部に連通してインク滴を飛翔させるのに適した開口となる深度を備えた部分と、外部からインクの供給を受けるのに適した深度を備えた部分とを有し、隔壁により一定ピッチで隔てられた溝と、前記各溝に電気的に分離して形成された電極とを備え、かつ厚み方向に分極された複数の圧電体基板を前記溝の開放面を一致させ、かつ分極方向が相反するようにして一体に固定するとともに、前記開口側とは反対側にインク供給手段を設けてなるインクジェット記録ヘッド。

【請求項2】　インク溜め部を形成する深度を備える部分と、一側部に連通してインク滴を飛翔させるのに適した開口となる深度を備えた部分と、外部からインクの供給を受けるのに適した深度を備えた部分とを有し、隔壁により一定ピッチで隔てられた溝と、前記各溝に電気的に分離して形成された電極とを両面に備え、かつ厚み方向に分極された中央基板と、インク溜め部を形成する深度を備える部分と、一側部に連通してインク滴を飛翔させるのに適した開口となる深度を備えた部分と、外部からインクの供給を受けるのに適した深度を備えた部分とを有し、隔壁により一定ピッチで隔てられた溝と、前記各溝に電気的に分離して形成された電極とを片面に備え、かつ厚み方向に分極された2枚の圧電体基板を中央基板の溝の開放面を一致させ、かつ分極方向が相反するようにして一体に固定するとともに、前記開口側とは反対側にインク供給手段を設けてなるインクジェット記録ヘッド。

【請求項3】　分極処理が施された第1、第2の圧電体基板を前記分極方向が対向するように張合わせ、第1の圧電体基板の表面から第2の圧電体基板に到達してインク溜め部を形成する深度を備える部分と、第1の圧電体基板の一側部に連通してインク滴を飛翔させるのに適した開口となる深度を備えた部分と、外部からインクの供給を受けるのに適した深度を備えた部分とを有し、隔壁により一定ピッチで隔てられた溝が複数形成された基板と、前記基板の溝の開口面を封止する蓋体と、前記溝にインクを供給する部材を備えたインクジェット記録ヘッド。

【請求項4】　分極処理が施された第1、第2、第3の圧電体基板を前記分極方向が対向するように張合わせ、表面に位置する第1、及び第3の圧電体基板の表面から中央部に固定された第2の圧電体基板に到達してインク溜め部を形成する深度を備える部分と、第1の圧電体基板の一側部に連通してインク滴を飛翔させるのに適した開口となる深度を備えた部分と、外部からインクの供給を受けるのに適した深度を備えた部分とを有し、隔壁により一定ピッチで隔てられた溝が複数形成された基板と、前記基板の両表面の溝の開口面を封止する2枚の蓋体と、前記溝にインクを供給する部材を備えたインクジェット記録ヘッド。

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【請求項5】　分極処理が施された第1、第2の圧電体基板を前記分極方向が対向するように張合わせ、第1の圧電体基板の表面から第2の圧電体基板に到達してインク溜め部を形成する深度を備えるとともに両端が封止され、隔壁により一定ピッチで隔てられた溝が複数形成された基板と、前記基板の溝に開放面側に固定され、かつ前記基板の溝に連通してノズル開口を形成する溝を備えた蓋体と、前記溝にインクを供給する部材を備えたインクジェット記録ヘッド。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、圧電振動子の運動エネルギによりインク室内のインクを液滴として飛翔させて記録用紙にドットを形成するインクジェット記録ヘッドに関する。

【0002】

【従来の技術】インクを液滴として飛翔させて記録用紙にドットを形成させて文字や図形を印刷するインクジェット式プリンタに用いられている記録ヘッドは、駆動信号が印加させると機械的変位を生じる圧電体によりインク室のの圧力を変化させるもので、例えば特開昭47－2006号公報に示されているように、圧力室の一部をダイヤフラムにより構成するとともに、このダイヤフラムに薄板状に成型された圧電体基板を貼着して構成されている。このインクジェット式記録ヘッドは、駆動信号を圧電素子に印加することにより、インク室を収縮させ、これに連通しているノズル開口からインクをインクを液滴として外部に飛翔させて記録ヘッドにドットを形成するものであるが、ダイヤフラムに圧電素子板を貼着する関係上、この作業を可能ならしめるために圧力室の大きさを或る程度大きくせねばならない半面、印字品質を向上させるためにノズル開口が極めて微小な間隔で配列されているため、これら両者を流路により接続せねばならず、構造が複雑化するという問題がある。

【0003】このような問題を解消するために、例えば特公昭60－8953号公報に示されているようにノズル開口に対向させて圧電振動子の先端を配置し、圧電素子の変位によりインクに動圧を発生させてインク滴を飛翔させるようにしたインクジェット式記録ヘッドも提案されている。これによれば圧力室とノズルとを接続する流路が不要となって構造の簡素化を図ることができる半面、圧電振動子とインクとの音響インピーダンスに大きな隔たりがあるため、圧電素子で発生したエネルギを液滴形成に有効に利用できないという問題がある。

【0004】またこのような問題を解消するために特開昭63－247051号公報に示されているように、圧電体基板の一方の表面にドット形成領域に合せて複数の流路を形成するとともに、これら流路の壁面に電極を設けることにより、壁面に剪断モードでの変形を生じさせ

て溝の容積を変化させるインクジェット式記録ヘッドが提案されている。この記録ヘッドによれば、流路に存在するインクを直接圧縮することができるから、インク室とノズル開口との間を連通する流路が不要となって構造の簡素を図ることができるばかりでなく、インク室を直接圧縮するから高い効率でもって液滴を発生させるできるという利点を備えている。

【０００５】

【発明が解決しようとする課題】しかしながら、液滴を安定して飛翔させるためのノズル開口を形成するための部材、いわゆるノズルプレートを必要とするため、圧電体基板にノズルプレートを固定することが必要となる。しかしながら、圧電体基板にノズルプレートを固定するため、接合部が圧電体基板の伸縮を直接受けるため、接着強度が低下するばかりでなく、極めて微小な部分に接着剤の塗布が必要となって製造作業が複雑化するばかりでなく、ノズルプレートの位置ずれ等により形成されるドットが一定しないという問題がある。本発明は、このような問題に鑑みてなされたものであって、その目的とするところは、ノズルプレートの取り付けを不要として製造工程の簡素化と、安定したドットを形成することができる新規なインクジェット記録ヘッドを提供することである。

【０００６】

【課題を解決するための手段】このような問題を解消するために本発明においては、インク溜め部を形成する深度を備える部分と、一側部に連通してインク滴を飛翔させるのに適した開口となる深度を備えた部分と、外部からインクの供給を受けるのに適した深度を備えた部分とを有し、隔壁により一定ピッチで隔てられた溝と、前記各溝に電気的に分離して形成された電極とを備え、かつ厚み方向に分極された複数の圧電体基板を前記溝の開放面を一致させ、かつ分極方向が相反するようにして一体に固定するとともに、前記開口側とは反対側にインク供給手段を設けるようにした。

【０００７】

【作用】インク滴を形成すべき領域の溝、及びこれの両隣の溝の電極とにそれぞれ異なる極性の電圧を印加すると、溝を隔てている隔壁がインク滴を形成すべき溝側に剪断変形する。この結果、インク滴を形成すべき溝の容積が縮小されて、ここに存在するインクが溝の開口からそのままインク滴となって外部に飛翔することになる。

【０００８】

【実施例】そこで以下に本発明の詳細を図示した実施例に基づいて説明する。図１は、本発明の第１実施例のインクジェット式記録ヘッドを示すものであって、図中符号１は、中心部に配置されるジルコン酸鉛等の圧電現象を示す材料からなる中央に配置される圧電体基板（以下、中央基板という）で、表裏両面に後述する溝３，３，３‥‥、４，４，４‥‥が形成できる程度の厚みを

有していて、厚み方向に分極処理が施されており、またその表面、及び裏面にはそれぞれ図２に示したように等間隔に流路となる溝３，３，３‥‥、４，４，４‥‥が形成されている。

【０００９】また各面の溝３，３，３‥‥、４，４，４‥‥は、同一材料からなる隔壁５，５，５‥‥、６，６，６‥‥により分離されていて、それぞれ１／２ピッチずれるように位置決めされている。溝３，３，３‥‥、４，４，４‥‥はその一端がノズル開口５０，５０，５０‥‥５１，５１，５１‥‥を形成するように中央基板１の一側端１ａに連通し、また他端がインク供給部材１０に連通してさせられている。また中央基板１の後端表面には、各溝３，３，３‥‥、４，４，４‥‥の壁面と底面に連続して設けられている電極１７と図示しない駆動回路に接続するケーブル１２とを接続する配線パターン１３が形成されている。

【００１０】これら溝３，４は、図３に示したようにノズル開口となる先端部３ａ、４ａは、液滴を飛翔させるのに適した開口サイズとなるように深度が浅く、また中央部３ｂ、４ｂはインク滴の形成に必要な量のインクを収容できる程度の容積となるように深く、さらには後端側はインク供給部材１０の開口１０ａと適当な流体抵抗を持つような深度となるように形成されている。各溝３、４は、図４に示したようにその底部、側壁には隣接する隔壁５、６との間に空白部１５により電気的に分離された金属層を形成して電極１６，１６，１６‥‥、１７，１７，１７‥‥が設けられていて駆動回路から駆動信号の印加を受けるようになっている。

【００１１】図中符号２０、中央基板と同一の圧電現象を示す材料からなる上基板で、図６に示したように中央基板１に形成されている溝３，３，３‥‥と対向する位置に溝２１が形成されており、これら溝２１は、ノズル開口となる先端部２１ａが浅く、またインク室となる部分２１ｂが深く、さらに後端部２１ｃがインク供給部材１０の開口１０ａに連通するように形成されている。これら各溝２１，２１，２１‥‥は、隔壁２２，２２，２２‥‥により隔離され、また壁面、底面には空白部２３により電気的に分離された金属層を形成して電極２４，２４，２４‥‥が設けられている。これら電極２４，２４，２４‥‥は、中央基板１と重ね合せられた時に中央基板１の電極１６，１６，１６‥‥と導電関係を形成するようになっている。

【００１２】図中符号３０は、中央基板１と同一の圧電現象を示す材料からなる下基板で、図９に示したように中央基板１に形成されている溝４，４，４‥‥と対向する位置に溝３１が形成されており、これら溝３１は、ノズル開口となる先端部３１ａが浅く、またインク室を形成する部分３１ｂが深く、さらに後端部３１ｃがインク供給部材１０の開口１０ａと連通するようになっている。これら各溝３１，３１，３１‥‥は、隔壁３２，３

2，32‥‥により隔離されて、また壁面、底面には空白部33により電気的に分離された金属層を形成して電極34，34，34‥‥が設けられている。これら電極34，34，34‥‥は中央基板1と重ね合せられた時に中央基板1の電極17，17，17‥‥都道伝関係を形成するようになっている。

【0013】図12は、上述した中央基板1、上基板20、及び下基板30の加工方法の一実施例を示すものであって、水平なワーク固定台40に所定の角度、たとえば2度の楔状台41を固定し、これの表面に所定厚さの圧電体基板42を固定する。

【0014】この状態でノズル開口となる先端部での食込み深さがノズル開口に適した値、たとえば30μmとなるようにダイシングソウ43の位置を設定し、ダイシングソウ43、またはワーク固定第40を相対的に一定距離だけ水平に移動させてカッテングする。これにより、楔状台41に規定された角度でダイシングソウの切代に相当する幅、たとえば90μmの溝が形成されることになる。一定長の切削を行なった時点で固定台40またはダイシングソウ43をなおも水平に移動させながらダイシングソウ43をゆっくりと引き上げることにより端部形状が完成する（I）。

【0015】1本の溝の形成が終了した段階で、ワーク固定台40、もしくはダイシングソウ43を所定間隔、たとえば170μmずらせて再度上記工程を繰り返すことにより必要な本数の溝を形成する。

【0016】溝44が形成された各圧電体基板の両面に、無電解メッキやスパッタリング、蒸着等の手法により基板表面にニッケル層45を所定の厚み、たとえば1μm形成し（II）、このニッケル層の表面に耐食性金属、たとえば金（Au）を所定の厚み、たとえば0．1μm形成する（III）。

【0017】ついで、隔壁の表面に形成されている金属層45，46を流路に平行な方向にダイシングソウ47などにより切断もしくはフォトリソグラフィによりエッチングして各流路のメッキ層を電気的に独立させる（IV）。このようにして構成された各基板は、中央基板1の溝3，4に一致するように各表面に上基板20と下基板30の各溝21，31を対向させて接着剤等により固定される。また上基板20と下基板30の後端部にインク供給部材10，10を、そのインク供給口10aを中央基板1の溝3，4の端部3a，4aに連通させて中央基板に固定する。また中央基板1の他方の表面に下基板30の溝31，31，31‥‥を対向させて接着する。

【0018】これにより図13に示したように上基板20、及び下基板30は、それぞれ中央基板1との接続面を境界として中央基板1の分極方向E_1と相反する分極方向E_2、E_3を持つように配置固定される。これら基板1，20，30に形成されている各溝は、先端部分でそれぞれ浅く形成された部分3a、21a、及び4a、3

1aにより図14に示したようにノズル開口50，50，50‥‥、51，51，51‥‥を、また中央部分で断面長水滴型のインク室を形成することになる。また上基板20，及び下基板30それぞれの各電極24，24，24‥‥、34，34，34は、中央基板1の各表面に形成されている電極17，17，17‥‥、18，18，18‥‥と接触して導電関係を形成することになる。

【0019】このように構成されたインクジェット式記録ヘッドは、図15に示したように上基板20と中央基板1の各電極24，24，24‥‥、17，17，17‥‥は、印字データ出力回路60からの信号により制御を受ける3ステート駆動回路61～67を介して駆動電源68に接続される。この状態でドットを形成すべき位置に対応するインク室70に一方の極、例えばマイナスを、またこのインク室70に隣接する2つのインク室71，72に設けられている電極に他方の極、例えばプラスを印加すると（図16）、ドットを形成すべきインク室70を区画している中央基板1の隔壁73，74、及び上基板20の隔壁75，76には、それぞれインク室70を対象線とするような電界F_1、F_2が作用することになる。このためこの隔壁73，74，75，76がインク室70側に剪断モードで湾曲することになって、インク室70の容積が収縮し、ここに存在しているインクが圧縮される。これによりインク室70のインクは、先端が絞られた開口50（図13）から外部に飛翔することになる。この開口50は、インク室70に比較してその断面積が絞られているから、ノズルと同等の作用を行うことになり、したがってノズルプレートなどのノズル開口形成部材を要することなくインク室のインクを最適な直径の液滴として記録用紙に飛翔させ、これにドットを形成することになる。

【0020】ドット形成が終了して駆動信号の印加が停止すると、今変形していた隔壁73，74，75，76は元の状態に復帰するので、この復帰の過程ではインク室が拡大することになり、したがってインク供給口10aからインク滴を形成したインク室70にインクが補給されて次のドット形成の準備が終了する。

【0021】なお、この実施例においてはインク室にインクが流入している状態で、インク室を区画している隔壁をインク室側にいきなり変形させることによりインクを吐出させているが、図17に示したように予備工程として、インク室70に隣接するインク室71，72の容積を膨張させる方向、つまり収縮時とは反対方向で、かつ電界強度の変化速度が小さな電界F_3、F_4を印加して上基板20、及び中央基板1の隔壁75，76、及び73，74を比較的緩慢に変形させてインク室70にインクを充填し、次いで図16に示したように隔壁75，76，73，74をインク室70側に急激に変形させてインク滴を吐出させことにより、インク室70に充分な量

のインクを充填させ、かつ隔壁７５，７６，７３，７４に蓄積されている弾性エネルギを利用して高い効率でインク滴を発生させることができる。

【００２２】また、上述の実施例においては中央基板１の両面に溝を形成して２列のノズル開口を形成するようにしているが、上述の中央基板に相当する基板の一方の面にだけ溝を形成して１列だけのノズル開口を備えたものを構成しても同様の作用を奏することは明らかである。

【００２３】図１８（ａ）（ｂ）は、それぞれ本発明の他のインクジェット式記録ヘッドを構成する圧電体基板の構造を示す図であって、図中符号８０は、圧電体基板で、ジルコン酸鉛等の圧電現象を示す材料からなり、厚み方向に分極処理が施されており、またその表面には等間隔に流路となる溝８１，８１，８１‥‥が形成されている。

【００２４】各溝８１，８１，８１‥‥は、同一材料からなる隔壁８２，８２，８２‥‥‥‥により分離されていて、その一端がノズル開口を形成するように基板８０の一側端８０ａに連通し、また他端がインク供給口に連通するように形成されている。これら溝８１，８１，８１‥‥は、前述の実施例と同様にノズル開口となる先端部は、液滴を飛翔させるのに適した開口サイズとなるように深度が浅く、また中央部はインク滴の形成に必要な量のインクを収容できる程度の容積となるように深く、さらには後端側はインク供給部材の開口と適当な流体抵抗を持つような深度となるように形成されている。さらに各溝８１，８１，８１‥‥には、空白部８３によりその長手方向に２分するように底部、側壁に電極８４，８５が形成され、これら電極８４，８５はそれぞれ導電パターン８６，８７により外部接続可能とされている。

【００２５】また、これと対をなす他方の基板９０（同図（ｂ））は、前述と同様の圧電材料からなり、これの表面には接合面を対象とするように溝９１や電極９４，９５が形成されている。すなわち、圧電体基板９０の表面には等間隔に流路となる溝９１，９１，９１‥‥が形成されていて、これら各溝９１，９１，９１‥‥は、同一材料からなる隔壁９２，９２，９２‥‥‥‥により分離されている。これら溝９１，９１，９１‥‥は、一端がノズル開口を形成するように基板９０の一側端９０ａに連通し、また他端がインク供給口に連通するように形成されている。溝９１，９１，９１‥‥は、前述の実施例と同様にノズル開口となる先端部は、液滴を飛翔させるのに適した開口サイズとなるように深度が浅く、また中央部はインク滴の形成に必要な量のインクを収容できる程度の容積となるように深く、さらには後端側はインク供給部材の開口と適当な流体抵抗を持つような深度となるように形成されている。さらに各溝９１，９１，９１‥‥は、空白部９３によりその長手方向に２分するように底部、側壁に電極９４，９５が形成されている。これら電極９４，９５はそれぞれ導電パターン９６，９７により外部接続可能とされている。

【００２６】このように構成された圧電体基板８０，９０を２枚対向させて接着剤等により張合わせると、２枚の基板８０，９０は、その接続面を境界として相反する方向に分極極性E_4、E_5を持ち、また先端部分がそれぞれ浅く形成された部分より絞られたノズル開口を有する断面長水滴型のインク室を持つことになる。また基板８０の各溝８１に形成された２つの電極８４，８５と、基板９０の２つの電極９４，９５とは互いに接触して導電関係を形成し、１つのインク室にその長手方向に２つに分割された電極が形成されることになる。

【００２７】図１９は、上述した記録ヘッドの駆動方式を示すものであって、印字データ出力回路１００からの信号により制御を受ける３ステート駆動回路１０１の出力を、インク供給口１０３側の電極８５，９５には直接、またノズル側の電極８４，９４には、これら電極間を振動が伝播するのに要する時間を遅延時間とする遅延回路１０２を介して出力する。

【００２８】この実施例によれば、駆動信号が印加されると、まずインク供給口１０３側の電極８５，９５に信号が印加されるから、流路を構成している隔壁８２，９２の内、電極８５，９５の領域だけがインク室側に変形し、ここに存在するインクを圧縮して弾性波を生じさせる。遅延回路１０２に設定されている時間、（例えば分割されている電極の中心距離が２０ｍｍの場合には２０マイクロ秒）が経過すると、電極８５，９５からの弾性波が電極８４，９４に到達する。この時点で遅延回路１０２から信号が出力して電極８４，９４に駆動信号が印加されることになる。このため、電極８５，９５により発生した弾性波に重畳する形態で電極８４，９４領域の隔壁８２，９２によりインクをさらに圧縮することになるので、ノズル開口に向かうインクを高い効率で、しかも短い領域で圧縮することになり、シャープな圧力波をノズル開口に作用させてインク切れの良いインク滴を飛翔させることになる。

【００２９】なお、この実施例においては電極を溝の長手方向に２分割するようにしているが、長手方向に３つ以上に分割して、インク供給口側で発生した圧力波が各電極に到達するに要する時間だけ遅延させながら各分割された電極に駆動信号を印加するようにしても同様の作用を奏することは明らかである。

【００３０】図２０は、本発明の他の実施例をなすインクジェット記録ヘッドの電極の構造で示すものであって、図中符号１１０は、圧電体基板で、ここには前述したように圧電体基板１１０の一端１１０ａに連通してノズル開口を形成する溝１１１が形成されており、溝１１１の壁面、底面には隔壁に電界を作用させるための電極１１２，１１２が形成されている。この電極１１２，１１２は、ノズル開口となる側、つまり基板端部１１０ａ

側となる領域１１２ａと、インク供給口側となる領域１１２ｂとでは、インク供給口側の領域１１２ｂが厚くなるように構成されている。いうまでもなく、このような厚さが部分的に異なる電極は、蒸着時間やメッキ時間を制御することにより簡単に形成することが可能である。

【００３１】このような電極構造を採ると、圧電体基板よりも弾性係数の大きな金属によりインク供給口側の隔壁の弾性を増強することができるから、インク供給口側領域の隔壁の変形がノズル開口側よりも早くおこる。この変形により生じたインクの圧力波がノズル開口側に到達した時点では、この領域の隔壁が変形の途中の状態にあるから、インク供給口側から伝播してきた圧力波をさらに圧縮することになり、前述と同様にシャープな圧力波をノズル開口に作用させてインク切れの良いインク滴を飛翔させることになる。

【００３２】なお、この実施例においては電極を構成する金属層の厚みを溝の長手方向に２段階で変化させるようにしているが、図２０（ａ）に示したように圧電体基板１２０の溝１２１の長手方向に３段階以上に厚みを増分させた部分１２２ａ、１２２ｂ、１２２ｃを持つ電極１２２を形成したり、図２０（ｂ）に示したようにインク供給側が単調に厚くなる電極１２３を形成しても同様の作用を奏することは明らかである。

【００３３】図２２は、圧力波を集中させる他の実施例を圧電体基板に形成する溝の構造によって示すものであって、図中符号１３０は、圧電体基板１３１に形成された溝で、ノズル開口側には深い領域１３０ａが、またインク供給口側にはインク滴形成に障害を来さない程度に浅い領域１３０ｂが形成され、これらの壁面、底面に電極１３２が形成されている。この実施例によれば、電極１３２に印加された駆動信号により変形する隔壁１３３は、インク供給口側の高さH_1が、ノズル開口側の高さH_2に比較して小さいため、底面の拘束を受けて高い弾性係数を持つことになる。この結果、電極に駆動信号が印加されると、インク供給口側が最初に変形し、つづいて弾性係数の小さなノズル開口側が変形することになるから、インク供給口側から伝播して来た圧力波に重畳する形態でノズル開口側領域の隔壁が変形することになる。したがって、前述の実施例と同様にシャープな圧力波をノズル開口に作用させることができる。

【００３４】上述した図１９及至図２２に示した実施例によれば、図２３に示したようにインク供給口側で発生した圧力波（同図　Ｉ）が時間ΔＴをおいてノズル開口側に到来した時点で（同図　ＩＩ）、ここの領域を変形させることができるため、同図において点線により示したような裾が小さくかつ波高値の大きな圧力波をノズル開口に伝播させることが可能となる。この結果、吐出速度が速く、しかも継続時間の短いインク滴が発生することになり、曲りが小さく、しかも尾引きの発生がないインク滴を記録用紙に噴射することができる（同図　ＩＩＩ）。

【００３５】これに対して、上述のような対策を施さない場合には、図２４（Ｉ）に示したようにノズル開口からインク供給口までの全領域で同時に圧力波が発生し、これが順次ノズル開口に伝播するので、ちょうど水鉄砲からの液体噴出と同様に比較的長い時間をかけて飛出すことになる。このため、同図（ＩＩ）飛行速度が小さく、しかも長時間継続するインク滴が発生することになり、曲りやサテライトを生じて印字品質の低下を招くことになる。

【００３６】図２５は、本発明の第２の実施例を示すものであって、図中符号１４０は、ジルコン酸鉛などの圧電材料からなる基板で、後述する流路の最も深い部分の深さ、たとえば４００μｍの１／２よりも大きな厚み、たとえば１ｍｍに選定されていて、また予め厚み方向に分極処理がなされている。１４１は、前述の基板１４０と同一材料からなる上基板で、流路の最も深い部分のほぼ１／２と同程度の厚み、たとえば２００μｍに選定されていて、予め厚み方向に分極処理がなされている。これら基板１４０，１４１はその分極方向が対向するように接着剤で固定されて１枚の基板１４２に構成されている。

【００３７】この基板１４２は、図２６に示したように厚みの薄い方の基板１４１を表面とするようにして流路を構成する溝１４３，１４３，１４３‥‥が形成されている。これら溝は、幅が８５μｍに選ばれ、また図２７に示したように基板１４２の一端には後述する蓋体１５０と一体になってノズル開口を形成するように極めて浅い深度、たとえば深さ８０μｍの部分１４３ａと、基板1･41の厚さの約２倍の深度、たとえば深さ４００μｍの部分１４３ｂと、他端が基板１４１の途中で壁面により流路が断たれる浅い深度、たとえば１００μｍの部分１４３ｃとなるように形成されている。この部分１４３ｃは、後述するインク供給部材１５１の開口１５１ａと一定の流体抵抗、つまり印刷時にはインクの戻りを少なく、またインク供給時にはすみやかにインクが流入する程度となるようにその深度や長さが選択されている。

【００３８】各溝１４３，１４３，１４３‥‥は、それぞれ同一材料からなる隔壁１４６，１４６，１４６‥‥により分離されており、またその壁面、及び底面に金属層を設けて電極１４７，１４７，１４７‥‥が構成され、導電パターン１４８，１４８，１４８‥‥によりケーブル１４９に接続されて外部の駆動回路から駆動信号を受けるようになっている。

【００３９】再び図２５に戻って、１５０は、前述した蓋体で、基板１４２に形成された溝１４３，１４３，１４３の先端部１４３ａから後端部１４３ｃまでを密封するように基板１４２に固定されている。１５１は、インク供給部材で、そのインク供給口１５１ａが溝１４３の後端部１４３ｃの一部と連通する位置に取り付けられて

いる。図２８は、前述した溝１４３の形成方法の一実施例を示すものであって、図中符号１５５は、予め分極処理のなされた２枚の圧電体基板１５６，１５７を分極方向を対向させて張合わせて構成した基板で、薄い方の基板１５６を切削開始面とするようにして作業台に固定する。この状態でダイシングソウ１６０を溝の中央部分となる位置にセットして、基板の厚みの２倍程度となるまで切込み、ダイシングソウと基板１５５を相対的に移動させてインク室に適した長さの溝１６１を形成する（Ｉ）。

【００４０】このようにしてをインク室となる溝１６１を形成した段階でダイシングソウ１６０を引き上げて基板１５５の先端にダイシングソウ１６０を移動し、この部分を所定の深さまで切込む（ＩＩ）。さらに基板１５５の他方にダイシングソウ１６０を移動させて、インク供給口１５１ａとの接続部となる部分を形成する。このとき、使用するインクやインク供給圧に応じて切込み深さや長さを調整する。溝の形成が終了した段階でニッケルークロム合金の層を厚さ４μｍとなるように蒸着やスパッタリング、無電解メッキなどにより形成し、この層の表面に金（Ａｕ）の層を厚さ１μｍとなるように形成する。このようにして基板の表面、溝の壁面、底面の全面に金属層を形成した時点で、溝を区画している隔壁上面の金属層を除去して溝毎の電極を電気的に分離する。これに合せてこれら電極に接続する導電路を形成すべく基板後端部の表面の金属層を電極に対応させて分離する。

【００４１】図２９はこのようにして構成されたインクジェット式記録ヘッドの断面構造を示すものであって、この実施例においてインク供給口１５１ａにインクを補給すると、インクは溝１４３の端部１４３ｃから溝全体に流れ込みノズル開口１４５にメニスカスを形成する。この状態で、ドットを形成させるべきノズル開口に連通する溝の電極に一方の極を、またこれに隣接する２つの溝の電極に他方の極の電圧を印加すると、前述したようにドットを形成すべき溝を区画している隔壁がインク室側に剪断モードで変形してここの容積を縮小する。これによりインクは基板の溝の先端部１４３ａと蓋体１５０とにより形成されたノズル開口１４５から外部に飛翔することになる。ドットの形成が終了した時点で信号を断つと隔壁が元の状態になるから、溝の容積が拡大され、これにより溝の端部１４３ｃからインクが補給されて次の印刷に備える。

【００４２】なお、この実施例においては駆動信号の印加によりインク室を縮小して印刷するようにしているが、図１７により説明したようにインク室を拡開させてから印刷を行うこともできる。また、この実施例においても図１８（ａ）及至図２２（ｂ）に示した手法、つまり電極をノズル開口側とインク供給側とに少なくとも２つの領域に分割し、インク供給側から圧力波の伝播速度に合せて時間差を持たせて駆動信号を印加したり、またノズル開口側からインク供給側に順次厚くなる電極を形成したり、またインク供給側の溝の深さを浅くしたりしてノズル開口側の弾性係数を相対的に小さくすることを適用することにより、裾野が小さく、かつ波高値の大きな圧力波を発生させてインク切れのシャープなインク滴を発生できることは明らかである。

【００４３】図３０は、本発明の一実施例を示すものであって、図中符号１７０は、ジルコン酸鉛などの圧電材料からなる基板で、後述する流路の最も深い部分深さ、たとえば４００μｍの１／２よりも大きな厚み、たとえば１ｍｍに選定され、予め厚み方向に分極処理がなされている。１７１は、前述の基板１７０と同一材料からなる上基板で、流路の最も深い部分のほぼ１／２と同程度の厚み、たとえば２００μｍに選定されていて、予め厚み方向に分極処理がなされている。これら基板１７０，１７１はその分極方向が対向するように接着剤で固定されて１枚の板に形成されている。この基板１７２には、厚みの薄い方の基板１７１が開口面となるように幅８５μｍ程度の溝１７３が前述したように一定ピッチで形成されいる。これら溝１７１は、断面舟形で基板１７１の厚さの約２倍の深度、たとえば深さ４００μｍ程度となるように形成され、その壁面と底面には前述したのと同様に金属層を設けて電極１７６が形成されている。

【００４４】１８０は、蓋体で、図３１に示したように一端が端部に開放され、また他端が少なくとも圧電体基板１７１の溝１７３に連通する程度の長さを備え、かつ深さ、幅がともにインク滴を飛翔させるノズル開口を形成するのに適したサイズ、例えば８０μｍ程度の溝１８０ａが、溝１７３，１７３，１７３のピッチに合せて形成されて、先端部において蓋体１８０の溝１８０ａと圧電体基板１７１の表面とによりノズル開口１８１（図３２）を形成するように構成されている。１８２は、インク供給部材で、そのインク供給口１８２ａが溝１７３の他端で連通するように固定されている。

【００４５】この実施例において、前述したのと同様にドットを形成すべきノズル開口に連通する溝に隣接する２つの溝の電極１７６に駆動信号を印加すると、隔壁が変形してインク室が収縮する。これにより溝に収容されているインクが圧力を受け、蓋体１８０の段差１８０ａと圧電体基板１７２とにより形成されたノズル開口１８１からインク滴となって飛翔することになる。なお、この実施例においては駆動信号の印加によりインク室を縮小して印刷するようにしているが、図１７により説明したようにインク室を拡開させてから印刷を行うこともできる。

【００４６】また、この実施例においても図１８（ａ）及至図２２（ｂ）に示した手法、つまり電極をノズル開口側とインク供給側とに少なくとも２つの領域に分割し、インク供給側から圧力波の伝播速度に合せて時間差

を持たせて駆動信号を印加したり、またノズル開口側からインク供給側に順次厚くなる電極を形成したり、またインク供給側の溝の深さを浅くしたりしてノズル開口側の弾性係数を相対的に小さくすることを適用することにより、裾野が小さく、かつ波高値の大きな圧力波を発生させてインク切れのシャープなインク滴を発生できることは明らかである。

【００４７】図３３は、本発明の他の実施例を溝の構造でもって示すものであって、図中符号１９０は、厚み方向に分極処理がなされ、一方の厚みが形成すべき溝の最大深度の約１／２の厚みを有する圧電体基板１９１と，この基板１９１よりも厚めの圧電体基板１９２を分極方向を対向させて張合わせて構成された基板で、ノズル開口となる側からインク供給側に直線状に深度が単調に深くなるように溝が形成されている。

【００４８】この実施例によれば基板１９０のノズル開口となる側にダイシングソウを当てて、溝を形成すべき方向にダイシングソウと基板１９０を相対的に近づけながら切削を実行するだけで１回の操作で溝を形成することが可能となる。なお、図２５，図３０に示した実施例においては基板の一方の面にだけノズル開口を形成する場合を例に採って説明したが、図１に示したような２列配列の形態を採ることもできる。

【００４９】すなわち図３４に示したように中央に配置される圧電体基板２００の両面に形成すべき溝の１／２程度の厚みを備えた圧電体基板２０１，２０２を張り付け、これら圧電体基板２０１，２０２の側からそれぞれ所定のピッチで溝２０３，２０４を形成する。これら溝２０３，２０４にそれぞれ電気的に独立した電極を形成するとともに、蓋体２０５，２０６により封止し、それぞれの面の溝２０３，２０４に連通させてインク供給部材２０７，２０８を設けるようにすると、２列のノズル開口を備えた記録ヘッドを簡単に構成することができる。

【００５０】

【発明の効果】以上説明したように本発明においては、インク溜め部を形成する深度を備える部分と、一側部に連通してインク滴を飛翔させるのに適した開口となる深度を備えた部分と、外部からインクの供給を受けるのに適した深度を備えた部分とを有し、隔壁により一定ピッチで隔てられた溝と、これら溝に電気的に分離して形成された電極とを備え、かつ厚み方向に分極された複数の圧電体基板を前記溝の開放面を一致させ、かつ分極方向が相反するようにして一体に固定するとともに、開口側とは反対側にインク供給手段を設けることにより、ノズルプレートの取り付けを不要として製造工程の簡素化と、安定したドットを形成させることができる。

【図面の簡単な説明】

【図１】本発明のインクジェット式記録ヘッドの第１実施例を示す斜視図である。

【図２】中央に配置される圧電体基板の一実施例を示す斜視図である。

【図３】中央に配置される圧電体基板に形成されている溝の形状を示す断面図である。

【図４】中央に配置される圧電体基板に設けられている電極の構造を示す斜視図である。

【図５】中央に配置される圧電体基板の電極構造を示す図である。

【図６】中央に配置される圧電体基板と対にして用いられる圧電体基板の構造を示す斜視図である。

【図７】上記基板に形成されている溝の断面構造を示す図である。

【図８】圧電体基板の電極構造を示す図である。

【図９】中央に配置される圧電体基板と対にして用いられる他の圧電体基板の構造を示す斜視図である。

【図１０】上記基板に形成されている溝の断面構造を示す図である。

【図１１】上記基板に形成されている電極の断面構造を示す図である。

【図１２】同図（Ｉ）～（ＩＶ）は、それぞれ圧電体基板に溝を形成する工程と、電極を形成する工程とを示す図である。

【図１３】本発明の第１のインクジェット式記録ヘッドの構造を示す断面図である。

【図１４】本発明の第１のインクジェット式記録ヘッドをインク滴噴射側から見た図である。

【図１５】本発明のインクジェット式記録ヘッドの駆動方式を示す図である。

【図１６】インク滴吐出時における隔壁の変形状態を示す図である。

【図１７】本発明のインクジェット式記録ヘッドの他の駆動方式を示す説明図である。

【図１８】同図図（イ）、（ロ）はそれぞれ電極構造の他の実施例を示す斜視図である。

【図１９】図は、図１８に示した電極構造を採る記録ヘッドに適した駆動方式を示す図である。

【図２０】同図（イ）、（ロ）はそれぞれ電極構造の他の実施例を示すものであって、図（イ）は断面構造を、また図（ロ）は溝の開口側から見た構造を示すものである。

【図２１】同図（イ）、（ロ）は、それぞれ電極構造の他の実施例を溝の開口側から見た状態で示す図である。

【図２２】同図図（イ）、（ロ）は、それぞれ圧電体基板に形成される溝の他の実施例を示すものであって、図（イ）は断面図を、また図（ロ）は溝の開口側から見た上面図である。

【図２３】図１８及至図２２に示した電極構造や溝の構造を採った場合におけるインクの圧力波の状態と、これによりもたらされるインク滴の形態を示す図である。

【図２４】図１８及至図２２に示した対策を施さない場

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合にインクに生じる圧力波の状態と、これによりもたらされるインク滴の形態を示す図である

【図２５】本発明の第２の実施例を示す斜視図である。

【図２６】第２実施例に示したインクジェット記録ヘッドに使用される圧電体基板の構造を示す斜視図である。

【図２７】同上圧電体基板に形成される溝の形状を示す断面図である。

【図２８】同図（Ｉ）（ＩＩ）（ＩＩＩ）は、それぞれ圧電体基板に溝を形成する手法を示す図である。

【図２９】図２５に示した装置の断面構造を示す図である。

【図３０】本発明の第３の実施例を示す断面図である。

【図３１】図３０に使用する蓋部材の一実施例を示す斜視図である。

【図３２】同上記録ヘッドにおけるノズル開口側の構造を示す正面図である。

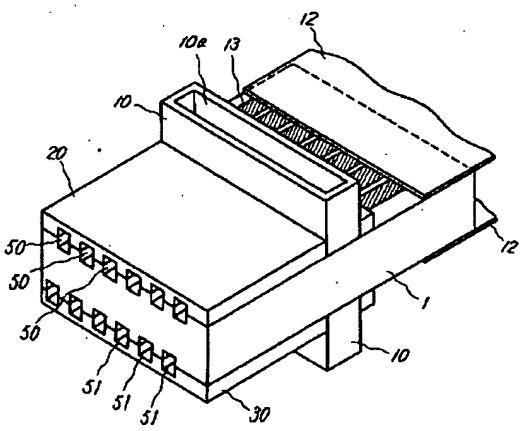
【図３３】本発明の第４実施例を溝の構造でもって示す圧電体基板の断面図である。

【図３４】上記第２及至第４実施例におけるノズル列をデュアル構造とする場合の圧電体基板と蓋体の位置関係、及び圧電体基板に形成される溝の構造を示す断面図である。

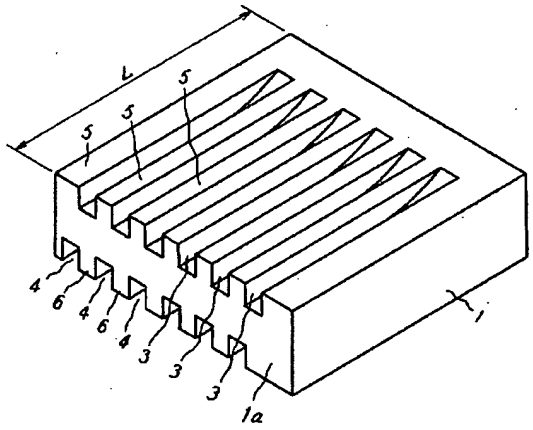
【符号の説明】

１、２０、３０　圧電体基板
３、４　溝
５、６　隔壁
１０　インク供給部材
１７、２４、１８、３４　電極
５０、５１　ノズル開口

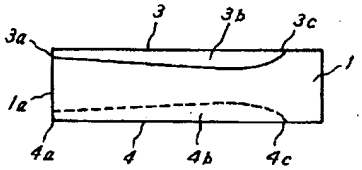
【図1】



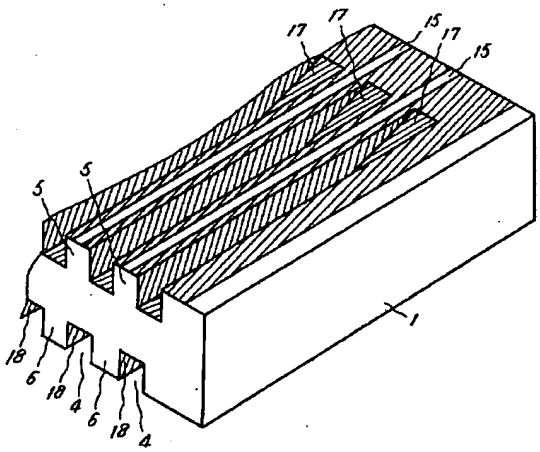
【図2】



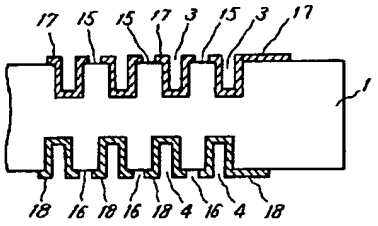
【図3】



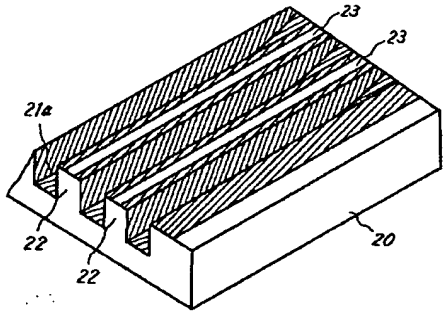
【図4】



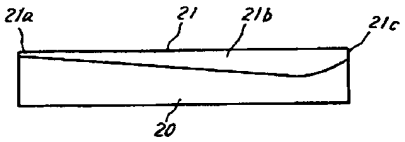
【図5】



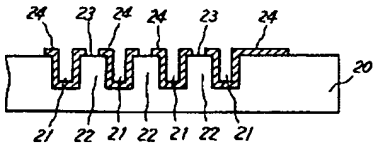
【図6】



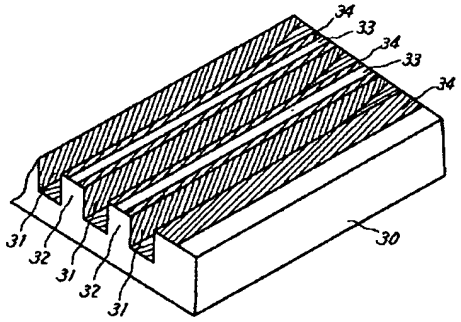
【図7】



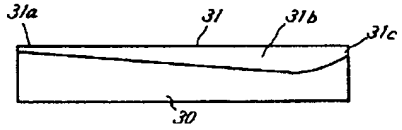
【図8】



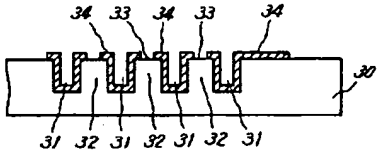
【図9】



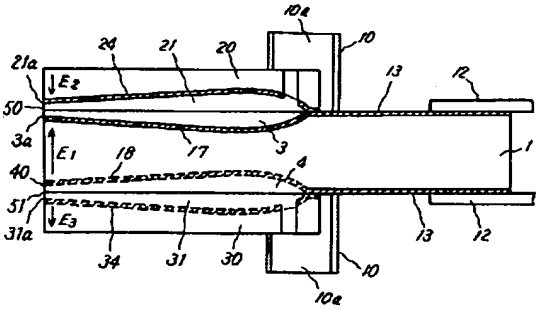
【図10】



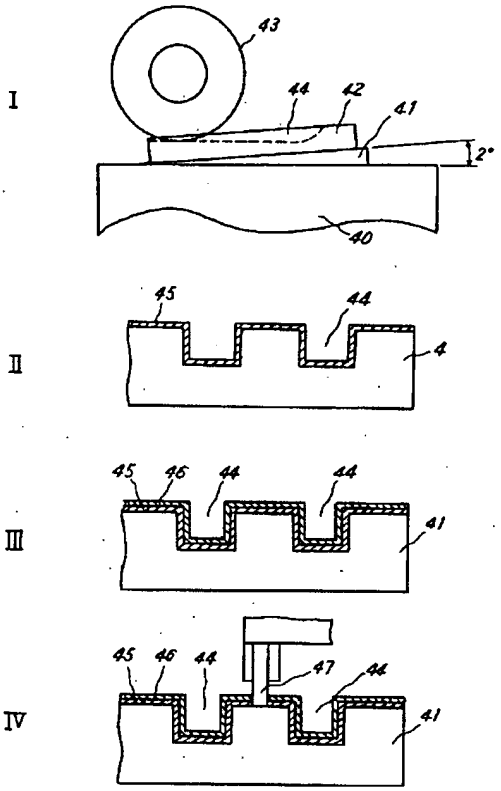
【図11】



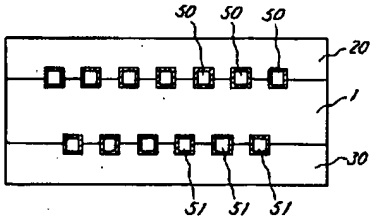
【図13】



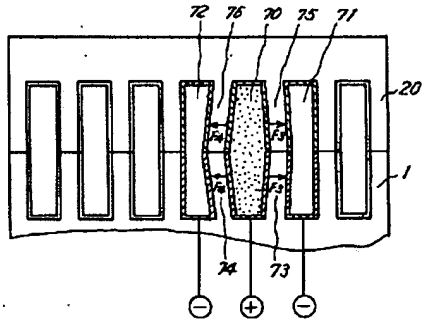
【図12】



【図14】



【図17】



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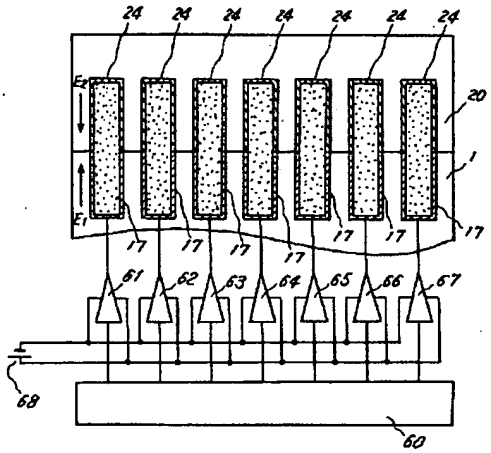

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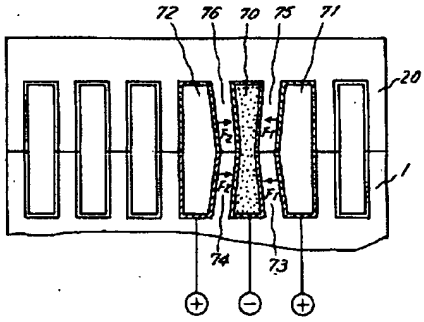

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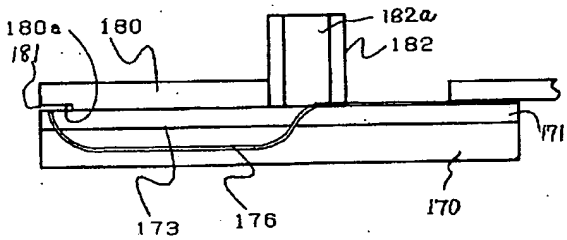

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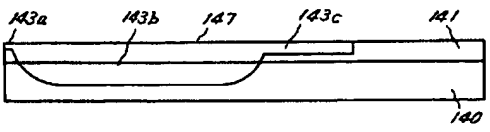

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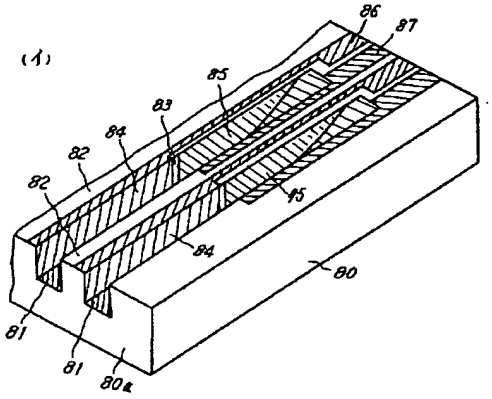

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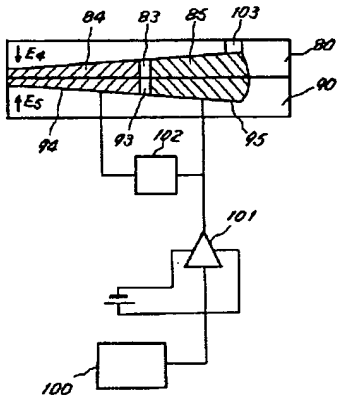

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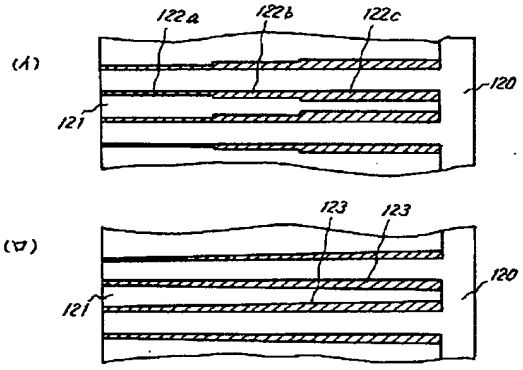

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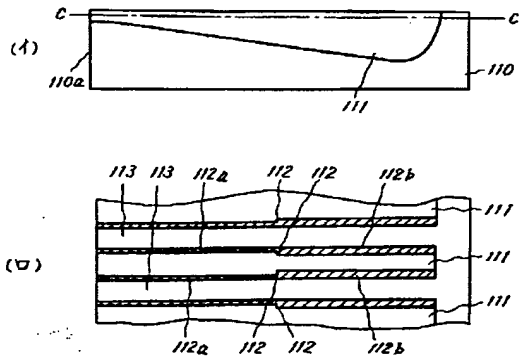

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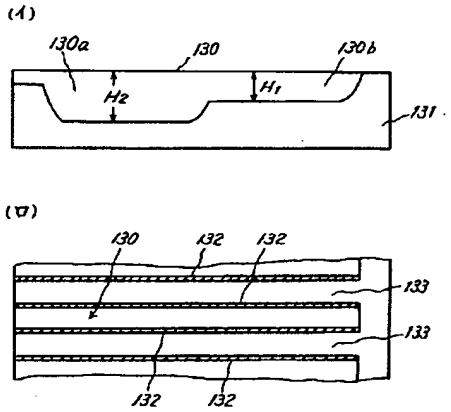

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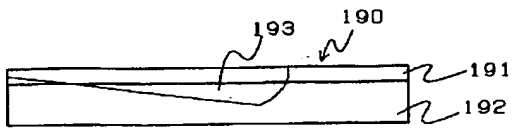

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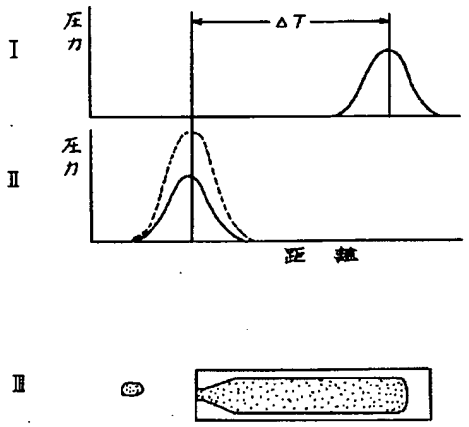

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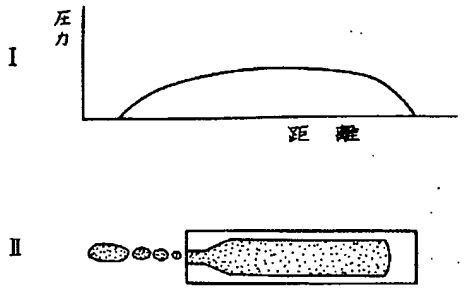

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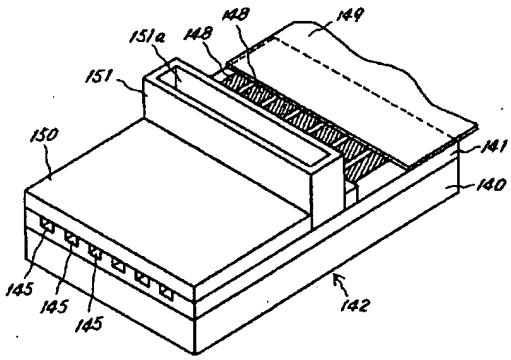

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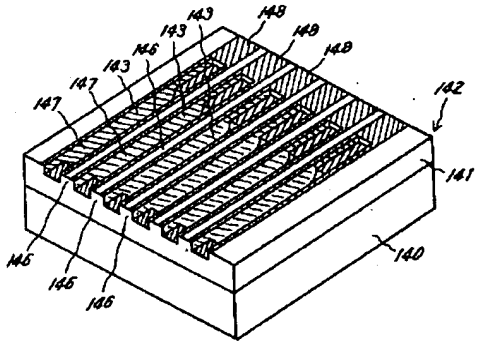

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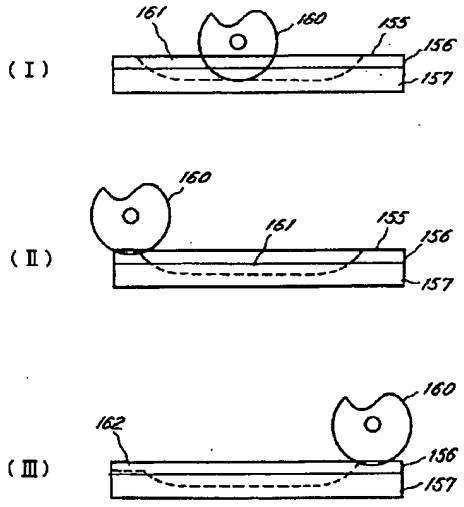

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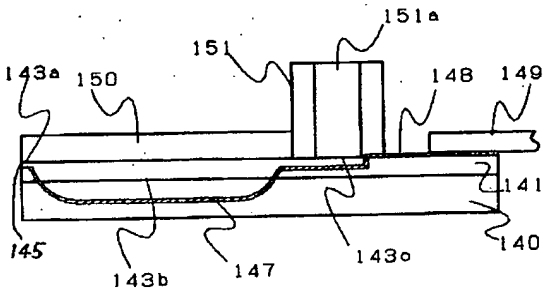

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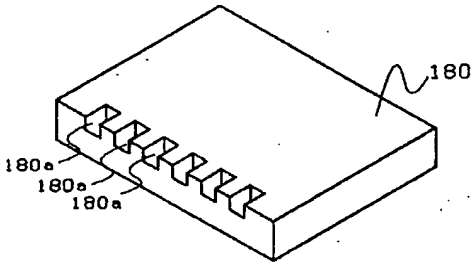

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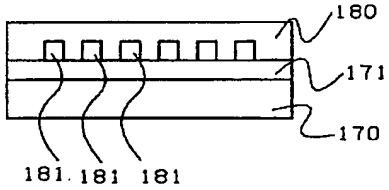

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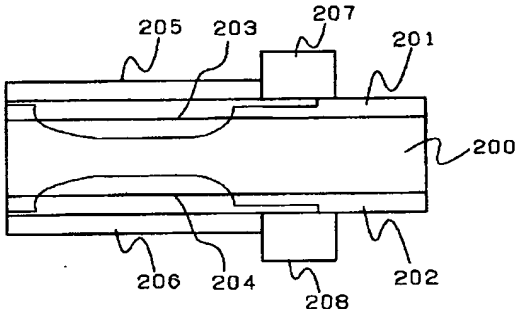

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1. JP,05-092561,A(1993)

JAPANESE [JP,05-092561,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS OPERATION EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS

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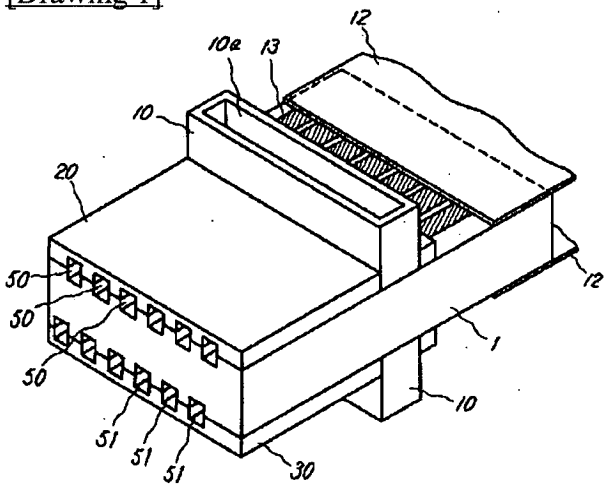
DRAWINGS

[Drawing 1]



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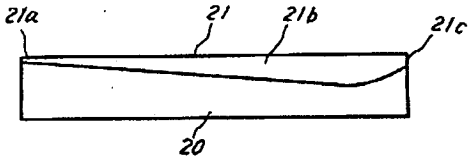

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the ink jet recording head which the ink of the ink interior of a room is made to fly as a drop by the kinetic energy of a piezoelectric transducer, and forms a dot in a record form.

[0002]

[Description of the Prior Art] The recording head used for the ink jet printer which ink is made to fly as a drop, is made to form a dot in a record form, and prints an alphabetic character and a graphic form It is that to which the pressure of ink room ** is changed with the piezo electric crystal which will produce mechanical displacement if a driving signal makes it impress. For example, while diaphram constitutes a part of pressure room as shown in JP,47-2006,A, the piezo electric crystal substrate cast in the shape of sheet metal is stuck on this diaphram, and it is constituted. Although this ink jet type recording head shrinks an ink room, makes the nozzle orifice which is open for free passage to this to ink fly outside by making ink into a drop and forms a dot in a recording head by impressing a driving signal to a piezoelectric device if , in order to close this activity on the relation which sticks a piezoelectric-device plate on diaphram -- the magnitude of a pressure room -- a certain extent -- it must enlarge, since the nozzle orifice is arranged at very minute spacing in order to raise a hemihedry and a quality of printed character These both must be connected by passage and there is a problem that structure is complicated.

[0003] A nozzle orifice is made to counter, the tip of a piezoelectric transducer is arranged as it is shown in JP,60-8953,B in order to solve such a problem for example, and the ink jet type recording head makes ink generate dynamic pressure with the variation rate of a piezoelectric device, and it was made to make an ink droplet fly is also proposed. Since big distance is in the acoustic impedance of a piezoelectric transducer and ink while according to this the passage which connects a pressure room and a nozzle becomes unnecessary and simplification of structure can be attained, there is a problem that the energy generated in the piezoelectric device cannot be used effective in drop formation.

[0004] Moreover, while forming two or more passage in one front face of a piezo electric crystal substrate according to a dot formation field as shown in JP,63-247051,A in order to solve such a problem, the ink jet type recording head to which a wall surface is made to produce the deformation in shear mode, and the volume of a slot is changed is proposed by preparing an electrode in the wall surface of these passage. According to this

recording head, since it not only can plan **** of structure, but the passage which opens between an ink room and nozzle orifices for free passage becomes unnecessary since the ink which exists in passage is directly compressible and an ink room is compressed directly, it has the advantage which generates a drop as it is also at high effectiveness that it can do.

[0005]

[Problem(s) to be Solved by the Invention] However, since the member for forming the nozzle orifice for being stabilized and making a drop fly and the so-called nozzle plate are needed, it is necessary for a piezo electric crystal substrate to fix a nozzle plate. However, since a nozzle plate is fixed to a piezo electric crystal substrate, in order that a joint may receive telescopic motion of a piezo electric crystal substrate directly, there is a problem that the dot which spreading of adhesives is needed for a very minute part, and bond strength not only falls, but is formed of a location gap of a nozzle plate etc. fabrication operation is not only complicated, but is not fixed. It is offering the new ink jet recording head which can form the dot which this invention's was made in view of such a problem, and the place made into the purpose made installation of a nozzle plate unnecessary, and was stabilized with the simplification of a production process.

[0006]

[Means for Solving the Problem] In order to solve such a problem, it sets to this invention. The part equipped with the depth used as a part equipped with the depth which forms the ink reservoir section, and opening suitable for it being open for free passage to one flank, and making an ink droplet fly, The slot which has the part equipped with the depth suitable for receiving supply of ink from the exterior, and was separated at constant pitch by the septum, As the open field of said slot was made in agreement [two or more piezo electric crystal substrates by which were equipped with the electrode formed in said each slot by dissociating electrically and polarization was carried out in the thickness direction] and the direction of polarization conflicted, while fixing to one, said opening side formed the ink supply means in the opposite side.

[0007]

[Function] If a polar electrical potential difference different, respectively is impressed to the electrode of the slot of the field which should form an ink droplet, and the slot of the neighbors of this, the septum which has separated the slot will shear-strain to the slot side which should form an ink droplet. Consequently, the volume of the slot which should form an ink droplet will be reduced, and it will become an ink droplet from opening of the ink fang furrow which exists here as it is, and will fly outside.

[0008]

[Example] Then, based on the example illustrating the detail of this invention, it explains below. Drawing 1 is what shows the ink jet type recording head of the 1st example of this invention. The sign 1 in drawing With the piezo electric crystal substrate (henceforth a central substrate) arranged in the center which consists of an ingredient in which piezoelectric phenomena, such as lead zirconate arranged in a core, are shown the slots 3, 3, and 3 later mentioned to front flesh-side both sides -- it has the thickness which is .... and extent which can form 4, 4, and 4 .., and polarization processing is performed in the thickness direction, and it was shown in the front face and a rear face at drawing 2 , respectively -- like -- etc. -- the slots 3, 3, and 3 which become spacing with passage .., 4 and 4, and 4 .. are formed.

[0009] moreover, the slots 3, 3, and 3 of each side .... and the septa 5, 5, and 5 by which 4, 4, and 4 .. consists of the same ingredient .., 6 and 6, and 6 .. separate -- having -- **** -- respectively -- 1 / 2 pitch ****** -- it is positioned like. slots 3, 3, and 3 ...., 4 and 4, and 4 .. the end -- nozzle orifices 50, 50, and 50 .. are open for free passage to 1 side-edge 1a of the central substrate 1 so that 51, 51, and 51 .. may be formed, and the other end is made to be open for free passage and make it the ink feed zone material 10 Moreover, in the back end front face of the central substrate 1, it is each slots 3, 3, 3, ..., 4, and 4 and 4.. The circuit pattern 13 which connects the cable 12 connected with the electrode 17 prepared succeeding the wall surface and the base in the drive circuit which is not illustrated is formed.

[0010] As shown in drawing 3 , depth is shallow [the points 3a and 4a used as a nozzle orifice] so that it may become the opening size suitable for making a drop fly, and the center sections 3b and 4b of these slots 3 and 4 are deep so that it may become the volume of extent which can hold the ink of a complement in formation of an ink droplet, and further, the back end side is formed so that it may become opening 10a of the ink feed zone material 10, and the depth which has suitable fluid resistance. the metal layer electrically separated by the null section 15 among the septa 5 and 6 which adjoin the pars basilaris ossis occipitalis and a side attachment wall as each slots 3 and 4 were shown in drawing 4 -- forming -- electrodes 16, 16, and 16 ...., 17 and 17, and 17 .. are prepared and impression of a driving signal is received from a drive circuit.

[0011] With the upper substrate which consists of an ingredient in which the same piezoelectric phenomena as the sign 20 in drawing and a central substrate are shown The slot 21 is formed in the slots 3 and 3 currently formed in the central substrate 1 as shown in drawing 6 , and 3 .... and the location which counters. These slots 21 Point 21a used as a nozzle orifice is shallow, and partial 21b used as an ink room is deep, and it is formed so that back end section 21c may be further open for free passage to opening 10a of the ink feed zone material 10. Each [these] slots 21 and 21 and 21 .... are isolated by septa 22 and 22 and 22 .., and the metal layer electrically separated by the null section 23 is formed in a wall surface and a base, and electrodes 24 and 24 and 24 .. are prepared. These electrodes 24 and 24 and 24 .... form electric conduction relation with the electrodes 16 and 16 of the central substrate 1, and 16 .., when it piles up with the central substrate 1.

[0012] The sign 30 in drawing is the bottom substrate which consists of an ingredient in which the same piezoelectric phenomena as the central substrate 1 are shown. The slot 31 is formed in the slots 4 and 4 currently formed in the central substrate 1 as shown in drawing 9 , and 4 .... and the location which counters. These slots 31 Point 31a used as a nozzle orifice is shallow, and partial 31b which forms an ink room is deep, and back end section 31c is further open for free passage with opening 10a of the ink feed zone material 10. Each [these] slots 31 and 31 and 31 .... are isolated by septa 32 and 32 and 32 .., and the metal layer electrically separated by the null section 33 is formed in a wall surface and a base, and electrodes 34 and 34 and 34 .. are prepared. These electrodes 34 and 34 and 34 .... are the electrodes 17, 17, and 17 of the central substrate 1, when it piles up with the central substrate 1.. ****** relation is formed.

[0013] Drawing 12 shows one example of the processing approach of the central substrate 1 mentioned above, the upper substrate 20, and the bottom substrate 30, fixes the predetermined include angle 41, for example, the wedge-shaped base of 2 times, to

the level work-piece standing ways 40, and fixes the piezo electric crystal substrate 42 of predetermined thickness on the surface of this.
[0014] KATTENGU [the location of a dicing saw 43 is set up so that the penetrating depth in the point which serves as a nozzle orifice in this condition may become the value suitable for a nozzle orifice, for example, 30 micrometers, and / a dicing saw 43 or work-piece immobilization 40th / only fixed distance makes it move horizontally and] relatively. The width of face which is equivalent to the OFF cost of a dicing saw by this at the include angle specified on the wedge-shaped base 41, for example, a 90-micrometer slot, will be formed. An end shape is completed by pulling up a dicing saw 43 slowly, moving horizontally standing ways 40 or a dicing saw 43 still more, when fixed length is cut (I).
[0015] In the phase which formation of one slot ended, the slot of a required number is formed for the work-piece standing ways 40 or a dicing saw 43 predetermined spacing, for example, by being able to shift 170 micrometers and repeating the above-mentioned process again.
[0016] both sides of each piezo electric crystal substrate in which the slot 44 was formed -- technique, such as electroless deposition, and sputtering, vacuum evaporationo, -- a substrate front face -- the nickel layer 45 -- predetermined thickness, for example, 1 micrometer, -- forming -- the front face of (II) and this nickel layer -- a corrosion-resistant metal (Au), for example, gold, -- predetermined thickness -- for example, 0.1 micrometers is formed (III).
[0017] Subsequently, the metal layers 45 and 46 currently formed on the surface of the septum are etched in the direction parallel to passage by cutting or the photolithography with a dicing saw 47 etc., and the deposit of each passage is made to become independent electrically (IV). Thus, each constituted substrate makes each slots 21 and 31 of the upper substrate 20 and the bottom substrate 30 counter each front face, and is fixed by adhesives etc. so that it may be in agreement with the slots 3 and 4 of the central substrate 1. Moreover, open the ink feed zone material 10 and 10 for free passage in the back end section of the upper substrate 20 and the bottom substrate 30, the edges 3a and 4a of the slots 3 and 4 of the central substrate 1 are made to open the ink feed hopper 10a for free passage, and it fixes to a central substrate. Moreover, the slots 31 and 31 of the bottom substrate 30 and 31 .... are made to counter the front face of another side of the central substrate 1, and it is pasted.
[0018] As this showed drawing 13 , arrangement immobilization of the upper substrate 20 and the bottom substrate 30 is carried out so that it may have the directions E2 and E3 of polarization which disagree with the direction E1 of polarization of the central substrate 1 bordering on a connection side with the ******** central substrate 1. the parts 3a and 21a shallowly formed by part for a point, respectively, and 4a and 31a showed each slot currently formed in these substrates 1, 20, and 30 to drawing 14 -- as -- nozzle orifices 50, 50, and 50 ...., 51 and 51, and 51 .. moreover, the ink room of a cross-section length waterdrop mold will be formed in a central part. moreover, the upper substrate 20 and the bottom substrate 30 -- the electrodes 17, 17, and 17 with which each electrode 24, 24, 24, ..., 34 of each, and 34 and 34 are formed in each front face of the central substrate 1 .., 18 and 18, and 18 .. will be contacted and electric conduction relation will be formed.
[0019] thus, the constituted ink jet type recording head was shown in drawing 15 -- as --

each electrodes 24, 24, and 24 of the upper substrate 20 and the central substrate 1 -- it connects with the drive power source 68 through .... and 3 State drive circuits 61-67 in which 17, 17, and 17 .. receives control with the signal from the printing data output circuit 60. In the ink room 70 corresponding to the location which should form a dot in this condition, one pole, Minus to the electrode prepared in two ink rooms 71 and 72 which adjoin this ink room 70 again For example, the pole of another side, For example, when plus is impressed (drawing 16), the electric fields F1 and F2 which make the ink room 70 an object line, respectively will act on the septa 73 and 74 of the central substrate 1 which has divided the ink room 70 which should form a dot, and the septa 75 and 76 of the upper substrate 20. For this reason, these septa 73, 74, 75, and 76 will curve in shear mode to the ink room 70 side, the volume of the ink room 70 contracts, and the ink which exists here is compressed. The ink of the ink room 70 will fly outside by this from the opening 50 (drawing 13) to which the tip was extracted. Since that cross section is extracted as compared with the ink room 70, this opening 50 will make the ink of an ink room fly in a record form as a drop of the optimal diameter, without performing an operation equivalent to a nozzle, therefore requiring nozzle orifice formation members, such as a nozzle plate, and will form a dot in this.

[0020] If dot formation is completed and impression of a driving signal stops, since the septa 73, 74, 75, and 76 which were deforming now will return to the original condition, ink is supplied to the ink room 70 which an ink room will be expanded in process of this return, therefore formed the ink droplet from ink feed hopper 10a, and preparation of the next dot formation is completed.

[0021] In addition, although it is in the condition that ink is flowing into the ink room in this example and ink is made to breathe out by making the septum which has divided the ink room transform into an ink room side suddenly As shown in drawing 17 , at the time of the direction which expands the volume of the ink rooms 71 and 72 contiguous to the ink room 70, i.e., contraction, it is an opposite direction as a reserve process. And the change rate of field strength impresses the small electric fields F3 and F4, make it transform comparatively slowly the septa 75 and 76 of the upper substrate 20 and the central substrate 1, and 73 and 74, and it fills up the ink room 70 with ink. Make septa 75, 76, 73, and 74 transform into the ink room 70 side rapidly, and an ink droplet is made to breathe out, as shown in drawing 16 . Subsequently, by things An ink droplet can be generated at high effectiveness using the elastic energy which is made filled up with the ink of sufficient amount for the ink room 70, and is accumulated in septa 75, 76, 73, and 74.

[0022] Moreover, although a slot is formed in both sides of the central substrate 1 in an above-mentioned example and he is trying to form the nozzle orifice of two trains, even if it constitutes what formed the slot only in one field of the substrate equivalent to an above-mentioned central substrate, and was equipped with the nozzle orifice of only one train, it is clear to do the same operation so.

[0023] Drawing 18 (a) and (b) are drawings showing the structure of the piezo electric crystal substrate which constitutes other ink jet type recording heads of this invention, respectively, the sign 80 in drawing is a piezo electric crystal substrate, it consists of an ingredient in which piezoelectric phenomena, such as lead zirconate, are shown, and polarization processing is performed in the thickness direction, and the slots 81 and 81 which serve as passage at equal intervals, and 81 .... are formed in the front face.

[0024] the septa 82, 82, and 82 by which each slots 81 and 81 and 81 .... consist of the same ingredient -- it is formed so that .... may dissociate, it may be open for free passage to 1 side-edge 80a of a substrate 80 so that the end may form a nozzle orifice, and the other end may be open for free passage to an ink feed hopper. The point from which these slots 81 and 81 and 81 .... become a nozzle orifice like the above-mentioned example has shallow depth so that it may become the opening size suitable for making a drop fly, and a center section is deep so that it may become the volume of extent which can hold the ink of a complement in formation of an ink droplet, and further, the back end side is formed so that it may become opening of ink feed zone material, and the depth which has suitable fluid resistance. further -- each slots 81, 81, and 81 -- electrodes 84 and 85 are formed in a pars basilaris ossis occipitalis and a side attachment wall so that it may be made the longitudinal direction by the null section 83 for 2 minutes, and external connection of these electrodes 84 and 85 is enabled with the electric conduction patterns 86 and 87 at ...., respectively.

[0025] Moreover, the substrate 90 (this drawing (b)) of another side which makes this and a pair consists of the same piezoelectric material as the above-mentioned, and a slot 91 and electrodes 94 and 95 are formed so that it may be aimed at a plane of composition on the surface of this. namely, the septa 92, 92, and 92 by which the slots 91 and 91 which serve as passage at equal intervals, and 91 .... are formed in the front face of the piezo electric crystal substrate 90, and each [these] slots 91 and 91 and 91 .. consist of the same ingredient .... dissociates. These slots 91 and 91 and 91 .... are formed so that it is open for free passage to 1 side-edge 90a of a substrate 90 so that an end may form a nozzle orifice, and the other end may be open for free passage to an ink feed hopper. The point from which slots 91 and 91 and 91 .... become a nozzle orifice like the above-mentioned example has shallow depth so that it may become the opening size suitable for making a drop fly, and a center section is deep so that it may become the volume of extent which can hold the ink of a complement in formation of an ink droplet, and further, the back end side is formed so that it may become opening of ink feed zone material, and the depth which has suitable fluid resistance. Furthermore, electrodes 94 and 95 are formed in the pars basilaris ossis occipitalis and the side attachment wall so that each slots 91 and 91 and 91 .... may be made into the longitudinal direction by the null section 93 for 2 minutes. External connection of these electrodes 94 and 95 is enabled with the electric conduction patterns 96 and 97, respectively.

[0026] Thus, when two constituted piezo electric crystal substrates 80 and 90 are made to counter and it is made to rival with adhesives etc., two substrates 80 and 90 will have the ink room of the cross-section length waterdrop mold which has the nozzle orifice extracted from the part in which it had polarization polarity E4 and E5 in the direction which conflicts bordering on the connection side, and a part for a point was formed shallowly, respectively. Moreover, two electrodes 84 and 85 formed in each slot 81 of a substrate 80 and two electrodes 94 and 95 of a substrate 90 will contact mutually, and will form electric conduction relation, and the electrode divided into two at the longitudinal direction will be formed in one ink room.

[0027] Drawing 19 shows the drive method of the recording head mentioned above, and outputs the time amount taken for vibration to spread the output of 3 State drive circuits 101 which receive control with the signal from the printing data output circuit 100 to the electrodes 85 and 95 by the side of the ink feed hopper 103, and to spread inter-electrode

[these] to the electrodes 84 and 94 by the side of direct and a nozzle through the delay circuit 102 made into a time delay.

[0028] According to this example, if a driving signal is impressed, since a signal is first impressed to the electrodes 85 and 95 by the side of the ink feed hopper 103, among the septa 82 and 92 which constitute passage, only the field of electrodes 85 and 95 deforms into an ink room side, the ink which exists here will be compressed and an elastic wave will be produced. If the time amount (20 microseconds when [For example,] the center distance of the electrode currently divided is 20mm) set as the delay circuit 102 passes, the elastic wave from electrodes 85 and 95 will reach electrodes 84 and 94. At this time, a signal will output from a delay circuit 102, and a driving signal will be impressed to electrodes 84 and 94. For this reason, since ink will be further compressed by the electrode 84 and the septa 82 and 92 of 94 fields with the gestalt superimposed on the elastic wave generated with electrodes 85 and 95, are high effectiveness, moreover, the ink which goes to a nozzle orifice will be compressed in a short field, a sharp pressure wave is made to act on a nozzle orifice, and the good ink droplet of an ink piece is made to fly.

[0029] In addition, even if it makes it impress a driving signal to the electrode which divided or more into three at the longitudinal direction, and was each divided while delaying only the time amount required for the pressure wave generated in the ink feed hopper side to reach each electrode although he is trying to divide an electrode into two in this example at the longitudinal direction of a slot, it is clear to do the same operation so.

[0030] The structure of the electrode of an ink jet recording head of making other examples of this invention shows drawing 20 , as mentioned above here, the slot 111 which is open for free passage to end 110a of the piezo electric crystal substrate 110, and forms a nozzle orifice is formed, the sign 110 in drawing is a piezo electric crystal substrate, and the electrode 112,112 for making electric field act on a septum is formed in the wall surface of a slot 111, and the base. This electrode 112,112 consists of field 112a which becomes the side which serves as a nozzle orifice, i.e., substrate edge 110a, and field 112b which becomes an ink feed hopper side so that field 112b by the side of an ink feed hopper may become thick. Needless to say, the electrode with which such thickness differs partially can be simply formed by controlling vacuum evaporationo time amount and plating time amount.

[0031] If such electrode structure is taken, since the elasticity of the septum by the side of an ink feed hopper can be reinforced with a metal with a bigger elastic modulus than a piezo electric crystal substrate, deformation of the septum of an ink feed hopper side field will start earlier than a nozzle orifice side. Since it is in the condition in the middle of the septum of this field being deformation when the pressure wave of the ink produced according to this deformation reaches a nozzle orifice side, the pressure wave spread from the ink feed hopper side will be compressed further, a sharp pressure wave is made to act on a nozzle orifice like the above-mentioned, and the good ink droplet of an ink piece is made to fly.

[0032] In addition, although he is trying to change the thickness of the metal layer which constitutes an electrode in this example to the longitudinal direction of a slot in two steps Partial 122a which carried out the increment of the thickness to the longitudinal direction of the slot 121 of the piezo electric crystal substrate 120 more than the three-stage as

shown in drawing 20 (a), As shown in drawing 20 (b), even if it forms the electrode 122 with 122b and 122c or an ink supply side forms the electrode 123 which becomes thick in monotone, it is clear to do the same operation so.

[0033] The structure of the slot which forms in a piezo electric crystal substrate other examples on which a pressure wave is centralized shows drawing 22 , the sign 130 in drawing is the slot formed in the piezo electric crystal substrate 131, field 130b shallow to extent to which deep field 130a does not cause a failure to an ink feed hopper side again at ink droplet formation is formed in a nozzle orifice side, and the electrode 132 is formed in these wall surfaces and a base. According to this example, as compared with the height H2 by the side of a nozzle orifice, since it is small, as for the septum 133 which deforms with the driving signal impressed to the electrode 132, the height H1 by the side of an ink feed hopper will have a high elastic modulus in response to constraint at the bottom. Consequently, when a driving signal is impressed to an electrode, an ink feed hopper side deforms first, and since a nozzle orifice side with a small elastic modulus will deform continuously, the septum of a nozzle orifice side field will deform with the gestalt superimposed on the pressure wave spread from the ink feed hopper side. Therefore, a sharp pressure wave can be made to act on a nozzle orifice like the above-mentioned example.

[0034] As shown in drawing 23 according to the example shown in drawing 19 **** drawing 22 mentioned above, it is a time of the pressure wave (this drawing I) generated in the ink feed hopper side setting time amount deltaT, and arriving at a nozzle orifice side (this drawing II), and since the field here can be made to transform, it becomes possible to make a nozzle orifice spread a small pressure wave with big peak value of the skirt as shown with the dotted line in this drawing. Consequently, the ink droplet which a regurgitation rate is quick, the short ink droplet of duration will moreover occur, and whose knee is small, and moreover does not have generating of tailing can be injected in a record form (this drawing III).

[0035] On the other hand, since a pressure wave occurs in coincidence in all the fields from a nozzle orifice to an ink feed hopper as shown in drawing 24 (I) and this spreads to a nozzle orifice one by one in not taking the above measures, it will elutriate over comparatively long time amount like the liquid jet from a water gun exactly. For this reason, the ink droplet which this drawing (II) flying speed is small, and moreover carries out long duration continuation will occur, a knee and a satellite will be produced, and deterioration of a quality of printed character will be caused.

[0036] By drawing 25 showing the 2nd example of this invention, the sign 140 in drawing is the substrate which consists of piezoelectric material, such as lead zirconate, and it is selected by the depth of the deepest part of the passage mentioned later, for example, bigger thickness than 1/2 [400-micrometer], for example, 1mm, and polarization processing is beforehand made in the thickness direction. 141 is the upper substrate which consists of the same ingredient as the above-mentioned substrate 140, it is selected by the thickness with about 1/comparable as 2 of the deepest part of passage, for example, 200 micrometers, and polarization processing is beforehand made in the thickness direction. It is fixed with adhesives and these substrates 140,141 are constituted by one substrate 142 so that the direction of polarization may counter.

[0037] Slot 143,143,143 .... which constitutes passage as were shown in drawing 26 and this substrate 142 uses the substrate 141 with thinner thickness as a front face is formed.

At the end of a substrate 142, these slots so that a nozzle orifice may be formed united with the lid 150 later mentioned as width of face was chosen as 85 micrometers and it was shown in drawing 27 With a very shallow depth of 80 micrometers, for example, depth, partial 143a, It is formed so that it may become the shallow depth with which passage is severed by the wall surface as partial 143b and the other end with a thickness [twice / about / the depth of a substrate 141] and a depth of 400 micrometers are a substrate 141, for example, partial 143c which is 100 micrometers. There is little this partial 143c about the return of ink at the time of opening 151a of the ink feed zone material 151 mentioned later, and fixed fluid resistance, i.e., printing, and at the time of ink supply, that depth and die length are chosen so that it may become extent with which ink flows into whether you are Sumiya.

[0038] Septum 146,146,146 .. which consists of the same ingredient, respectively dissociates, and a metal layer is prepared in the wall surface and a base, electrode 147,147,147 .. is constituted, electric conduction pattern 148,148,148 .. connects with a cable 149, and each slot 143,143,143 .... receives a driving signal from an external drive circuit.

[0039] It returns to drawing 25 again, and 150 is the lid mentioned above, and it is being fixed to the substrate 142 so that from point 143a of the slot 143,143,143 formed in the substrate 142 to back end section 143c may be sealed. 151 is ink feed zone material and is attached in a part of back end section 143c of the ink feed hopper 151a fang furrow 143, and a location open for free passage. Drawing 28 shows one example of the formation approach of the slot 143 mentioned above, and the sign 155 in drawing is the substrate which made the direction of polarization counter, and two piezo electric crystal substrates 156,157 with which polarization processing was made beforehand were made to rival, and constituted them, and is fixed to the bench by making the substrate 156 of the thinner one into a cutting initiation side. A dicing saw 160 is set to the location used as the central part of a slot in this condition, and the slot 161 of the die length which was made to move infeed, a dicing saw, and a substrate 155 relatively, and was suitable for the ink room is formed until it becomes about 2 times of the thickness of a substrate (I).

[0040] A dicing saw 160 is pulled up in the phase in which the slot 161 which does in this way and serves as an ink room in ** was formed, a dicing saw 160 is moved at the tip of a substrate 155, and this part is deeply cut by predetermined Mr. Fukashi (II). Furthermore, a dicing saw 160 is moved to another side of a substrate 155, and the part used as a connection with ink feed hopper 151a is formed. At this time, infeed depth and die length are adjusted according to ink and the ink supply pressure to be used. In the phase which formation of a slot ended, the layer of a nickel chromium alloy is formed by vacuum evaporationo, sputtering, electroless deposition, etc. so that it may become 4 micrometers in thickness, and a golden (Au) layer is formed in the front face of this layer so that it may become 1 micrometer in thickness. Thus, when a metal layer is formed all over the front face of a substrate, the wall surface of a slot, and a base, the metal layer on the top face of a septum which has divided the slot is removed, and the electrode for every slot is separated electrically. The metal layer of the front face of the substrate back end section is made to correspond to an electrode that the track connected to these electrodes according to this should be formed, and it dissociates.

[0041] If the cross-section structure of the ink jet type recording head constituted by carrying out drawing 29 in this way is shown and ink is supplied to ink feed hopper 151a

in this example, ink will flow into the whole slot from edge 143c of a slot 143, and will form a meniscus in a nozzle orifice 145. the electrode of the slot which is open for free passage in this condition to the nozzle orifice in which a dot should be made to form -- one pole -- moreover, if the electrical potential difference of the pole of another side is impressed to the electrode of two slots which adjoin this, the septum which has divided the slot which should form a dot as mentioned above will deform in shear mode, and will reduce the volume here to an ink room side. Ink will fly outside by this from the nozzle orifice 145 formed with point 143a of the slot on the substrate, and a lid 150. If a signal is severed when formation of a dot is completed, since a septum will be in the original condition, the volume of a slot is expanded, ink is supplied from edge 143c of a slot by this, and it prepares for the next printing.

[0042] In addition, although an ink room is reduced by impression of a driving signal in this example and he is trying to print, after making an ink room extend as drawing 17 explained, it can also print. Moreover, the technique shown in drawing 18 (a) **** drawing 22 (b) also in this example, That is, an electrode is divided into a nozzle orifice and ink supply side to at least two fields. According to the propagation velocity of a pressure wave, time difference is given from an ink supply side. Impress a driving signal or Moreover, by applying forming in an ink supply side the electrode which becomes thick one by one from a nozzle orifice side, and making shallow the depth of flute by the side of ink supply, and making small relatively the elastic modulus by the side of a nozzle orifice It is clear that Susono generates a pressure wave with big peak value, and can generate the sharp ink droplet of an ink piece small.

[0043] Drawing 30 shows one example of this invention, the sign 170 in drawing is the substrate which consists of piezoelectric material, such as lead zirconate, it is selected by the deepest partial depth of the passage mentioned later, for example, bigger thickness than 1/2 [400-micrometer], for example, 1mm, and polarization processing is beforehand made in the thickness direction. 171 is the upper substrate which consists of the same ingredient as the above-mentioned substrate 170, it is selected by the thickness with about 1/comparable as 2 of the deepest part of passage, for example, 200 micrometers, and polarization processing is beforehand made in the thickness direction. It is fixed with adhesives and these substrates 170,171 are formed in one plate so that the direction of polarization may counter. As the slot 173 with a width of face of about 85 micrometers mentioned above so that the substrate 171 with thinner thickness might serve as an effective area, it is formed at constant pitch and is in this substrate 172. These slots 171 are formed so that it may become the depth of about 400 micrometers of about 2 twice of the thickness of a substrate 171, for example, the depth, with cross-section boat form, a metal layer is prepared in the wall surface and base the same with having mentioned above, and the electrode 176 is formed.

[0044] It has the die length of extent which 180 is a lid, an end is wide opened at the edge as shown in drawing 31 , and the other end opens for free passage into the slot 173 of the piezo electric crystal substrate 171 at least. And the depth, size suitable for both width of face forming the nozzle orifice which makes an ink droplet fly, For example, it is constituted so that about 80 micrometers slot 180a may be formed according to the pitch of a slot 173,173,173 and may form a nozzle orifice 181 (drawing 32) in a point by slot 180a of a lid 180, and the front face of the piezo electric crystal substrate 171. 182 is ink feed zone material, and it is being fixed so that it may be open for free passage by the

other end of the ink feed hopper 182a fang furrow 173.
[0045] In this example, if a driving signal is impressed to the electrode 176 of two slots contiguous to the slot which is open for free passage to the nozzle orifice which should form a dot the same with having mentioned above, a septum will deform and an ink room will contract. A pressure is received, and the ink held in the slot by this serves as an ink droplet from the nozzle orifice 181 formed by level difference 180a of a lid 180, and the piezo electric crystal substrate 172, and will fly. In addition, although an ink room is reduced by impression of a driving signal in this example and he is trying to print, after making an ink room extend as drawing 17 explained, it can also print.
[0046] Moreover, the technique shown in drawing 18 (a) **** drawing 22 (b) also in this example, That is, an electrode is divided into a nozzle orifice and ink supply side to at least two fields. According to the propagation velocity of a pressure wave, time difference is given from an ink supply side. Impress a driving signal or Moreover, by applying forming in an ink supply side the electrode which becomes thick one by one from a nozzle orifice side, and making shallow the depth of flute by the side of ink supply, and making small relatively the elastic modulus by the side of a nozzle orifice It is clear that Susono generates a pressure wave with big peak value, and can generate the sharp ink droplet of an ink piece small.
[0047] It is what is shown that drawing 33 is also at the structure of a slot about other examples of this invention. The sign 190 in drawing polarization processing should do in the thickness direction -- about [of the maximum depth of the slot which one thickness should form] -- with the piezo electric crystal substrate 191 which has one half of thickness, and the substrate which made the direction of polarization counter, and the thicker piezo electric crystal substrate 192 was made to rival, and consisted of this substrate 191 From the side used as a nozzle orifice, the slot is formed so that depth may become deep in monotone at an ink supply side at the shape of a straight line.
[0048] According to this example, a dicing saw is applied to the side used as the nozzle orifice of a substrate 190, and it becomes possible to form a slot by one actuation only by performing cutting, bringing a dicing saw and a substrate 190 in the direction which should form a slot close relatively. In addition, although the case where a nozzle orifice was formed only in one field of a substrate in the example shown in drawing 25 and drawing 30 was taken and explained to the example, the gestalt of 2 train array as shown in drawing 1 can also be taken.
[0049] That is, as shown in drawing 34 , the piezo electric crystal substrate 201,202 equipped with about 1/2 thickness of the slot which should be formed in both sides of the piezo electric crystal substrate 200 arranged in the center is stuck, and a slot 203,204 is formed in a predetermined pitch from these piezo electric crystal substrate 201,202 side, respectively. If close with a lid 205,206, the slot 203,204 of each field is made open for free passage and the ink feed zone material 207,208 is formed while forming in these slots 203,204 the electrode which became independent electrically, respectively, the recording head equipped with the nozzle orifice of two trains can be constituted easily.
[0050]
[Effect of the Invention] The part equipped with the depth which forms the ink reservoir section in this invention as explained above, The part equipped with the depth used as opening suitable for it being open for free passage to one flank, and making an ink droplet fly, The slot which has the part equipped with the depth suitable for receiving

supply of ink from the exterior, and was separated at constant pitch by the septum, As the open field of said slot is made in agreement [two or more piezo electric crystal substrates by which were equipped with the electrode formed in these slots by dissociating electrically, and polarization was carried out in the thickness direction] and the direction of polarization conflicts, while fixing to one The dot which made installation of a nozzle plate unnecessary and was stabilized with the simplification of a production process can be made to form by forming an ink supply means in the opposite side with an opening side.

CLAIMS

[Claim(s)]

[Claim 1] The part equipped with the depth used as a part equipped with the depth which forms the ink reservoir section, and opening suitable for it being open for free passage to one flank, and making an ink droplet fly, The slot which has the part equipped with the depth suitable for receiving supply of ink from the exterior, and was separated at constant pitch by the septum, As the open field of said slot is made in agreement [two or more piezo electric crystal substrates by which were equipped with the electrode formed in said each slot by dissociating electrically and polarization was carried out in the thickness direction] and the direction of polarization conflicts, while fixing to one The ink jet recording head which comes to prepare an ink supply means in the opposite side with said opening side.

[Claim 2] The part equipped with the depth used as a part equipped with the depth which forms the ink reservoir section, and opening suitable for it being open for free passage to one flank, and making an ink droplet fly, The slot which has the part equipped with the depth suitable for receiving supply of ink from the exterior, and was separated at constant pitch by the septum, The central substrate by which equipped both sides with the electrode formed in said each slot by dissociating electrically, and polarization was carried out in the thickness direction, The part equipped with the depth used as a part equipped with the depth which forms the ink reservoir section, and opening suitable for it being open for free passage to one flank, and making an ink droplet fly, The slot which has the part equipped with the depth suitable for receiving supply of ink from the exterior, and was separated at constant pitch by the septum, As the open field of the slot of a central substrate is made in agreement [two piezo electric crystal substrates by which equipped one side with the electrode formed in said each slot by dissociating electrically, and polarization was carried out in the thickness direction] and the direction of polarization conflicts, while fixing to one The ink jet recording head which comes to prepare an ink supply means in the opposite side with said opening side.

[Claim 3] The 1st to which polarization processing was performed, and a part equipped with the depth which reaches the 2nd piezo electric crystal substrate from the front face of cladding and the 1st piezo electric crystal substrate, and forms the ink reservoir section so that said direction of polarization may counter the 2nd piezo electric crystal substrate, The part equipped with the depth used as opening suitable for it being open for free passage to one flank of the 1st piezo electric crystal substrate, and making an ink droplet fly, The ink jet recording head which the slot which has the part equipped with the depth suitable for receiving supply of ink from the exterior, and was separated at constant pitch

by the septum equipped with the substrate by which two or more formation was carried out, the lid which closes the effective area of the slot of said substrate, and the member by which ink is supplied to said slot.
[Claim 4] The 1st, 2nd, and 3rd piezo electric crystal substrate with which polarization processing was performed so that said direction of polarization may counter Cladding, A part equipped with the depth which reaches the 1st [which is located in a front face], and 2nd piezo electric crystal substrates which were fixed to the center section from the front face of the 3rd piezo electric crystal substrate, and forms the ink reservoir section, The part equipped with the depth used as opening suitable for it being open for free passage to one flank of the 1st piezo electric crystal substrate, and making an ink droplet fly, The substrate with which two or more formation of the slot which has the part equipped with the depth suitable for receiving supply of ink from the exterior, and was separated at constant pitch by the septum was carried out, the lid of two sheets which closes the effective area of the slot of both the front faces of said substrate, and the ink jet recording head equipped with the member by which ink is supplied to said slot.
[Claim 5] The 1st and 2nd piezo electric crystal substrate with which polarization processing was performed so that said direction of polarization may counter Cladding, The substrate with which the closure of the both ends was carried out, and two or more formation of the slot separated at constant pitch by the septum was carried out while having the depth which reaches the 2nd piezo electric crystal substrate from the front face of the 1st piezo electric crystal substrate, and forms the ink reservoir section, The ink jet recording head equipped with the lid equipped with the slot which is fixed to the slot of said substrate at an open field side, and is open for free passage into the slot of said substrate, and forms a nozzle orifice, and the member which supplies ink to said slot.

TECHNICAL FIELD

[Industrial Application] This invention relates to the ink jet recording head which the ink of the ink interior of a room is made to fly as a drop by the kinetic energy of a piezoelectric transducer, and forms a dot in a record form.

PRIOR ART

[Description of the Prior Art] The recording head used for the ink jet printer which ink is made to fly as a drop, is made to form a dot in a record form, and prints an alphabetic character and a graphic form It is that to which the pressure of ink room ** is changed with the piezo electric crystal which will produce mechanical displacement if a driving signal makes it impress. For example, while diaphram constitutes a part of pressure room as shown in JP,47-2006,A, the piezo electric crystal substrate cast in the shape of sheet metal is stuck on this diaphram, and it is constituted. Although this ink jet type recording head shrinks an ink room, makes the nozzle orifice which is open for free passage to this to ink fly outside by making ink into a drop and forms a dot in a recording head by impressing a driving signal to a piezoelectric device if , in order to close this activity on the relation which sticks a piezoelectric-device plate on diaphram -- the magnitude of a pressure room -- a certain extent -- it must enlarge, since the nozzle orifice is arranged at

very minute spacing in order to raise a hemihedry and a quality of printed character These both must be connected by passage and there is a problem that structure is complicated.

[0003] A nozzle orifice is made to counter, the tip of a piezoelectric transducer is arranged as it is shown in JP,60-8953,B in order to solve such a problem for example, and the ink jet type recording head makes ink generate dynamic pressure with the variation rate of a piezoelectric device, and it was made to make an ink droplet fly is also proposed. Since big distance is in the acoustic impedance of a piezoelectric transducer and ink while according to this the passage which connects a pressure room and a nozzle becomes unnecessary and simplification of structure can be attained, there is a problem that the energy generated in the piezoelectric device cannot be used effective in drop formation.

[0004] Moreover, while forming two or more passage in one front face of a piezo electric crystal substrate according to a dot formation field as shown in JP,63-247051,A in order to solve such a problem, the ink jet type recording head to which a wall surface is made to produce the deformation in shear mode, and the volume of a slot is changed is proposed by preparing an electrode in the wall surface of these passage. According to this recording head, since it not only can plan **** of structure, but the passage which opens between an ink room and nozzle orifices for free passage becomes unnecessary since the ink which exists in passage is directly compressible and an ink room is compressed directly, it has the advantage which generates a drop as it is also at high effectiveness that it can do.

EFFECT OF THE INVENTION

[Effect of the Invention] The part equipped with the depth which forms the ink reservoir section in this invention as explained above, The part equipped with the depth used as opening suitable for it being open for free passage to one flank, and making an ink droplet fly, The slot which has the part equipped with the depth suitable for receiving supply of ink from the exterior, and was separated at constant pitch by the septum, As the open field of said slot is made in agreement [two or more piezo electric crystal substrates by which were equipped with the electrode formed in these slots by dissociating electrically, and polarization was carried out in the thickness direction] and the direction of polarization conflicts, while fixing to one The dot which made installation of a nozzle plate unnecessary and was stabilized with the simplification of a production process can be made to form by forming an ink supply means in the opposite side with an opening side.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, since the member for forming the nozzle orifice for being stabilized and making a drop fly and the so-called nozzle plate are needed, it is necessary for a piezo electric crystal substrate to fix a nozzle plate. However, since a nozzle plate is fixed to a piezo electric crystal substrate, in order that a joint may receive telescopic motion of a piezo electric crystal substrate directly, there is a

problem that the dot which spreading of adhesives is needed for a very minute part, and bond strength not only falls, but is formed of a location gap of a nozzle plate etc. fabrication operation is not only complicated, but is not fixed. It is offering the new ink jet recording head which can form the dot which this invention's was made in view of such a problem, and the place made into the purpose made installation of a nozzle plate unnecessary, and was stabilized with the simplification of a production process.

MEANS

[Means for Solving the Problem] In order to solve such a problem, it sets to this invention. The part equipped with the depth used as a part equipped with the depth which forms the ink reservoir section, and opening suitable for it being open for free passage to one flank, and making an ink droplet fly, The slot which has the part equipped with the depth suitable for receiving supply of ink from the exterior, and was separated at constant pitch by the septum, As the open field of said slot was made in agreement [two or more piezo electric crystal substrates by which were equipped with the electrode formed in said each slot by dissociating electrically and polarization was carried out in the thickness direction] and the direction of polarization conflicted, while fixing to one, said opening side formed the ink supply means in the opposite side.

OPERATION

[Function] If a polar electrical potential difference different, respectively is impressed to the electrode of the slot of the field which should form an ink droplet, and the slot of the neighbors of this, the septum which has separated the slot will shear-strain to the slot side which should form an ink droplet. Consequently, the volume of the slot which should form an ink droplet will be reduced, and it will become an ink droplet from opening of the ink fang furrow which exists here as it is, and will fly outside.

EXAMPLE

[Example] Then, based on the example illustrating the detail of this invention, it explains below. Drawing 1 is what shows the ink jet type recording head of the 1st example of this invention. The sign 1 in drawing With the piezo electric crystal substrate (henceforth a central substrate) arranged in the center which consists of an ingredient in which piezoelectric phenomena, such as lead zirconate arranged in a core, are shown the slots 3, 3, and 3 later mentioned to front flesh-side both sides -- it has the thickness which is .... and extent which can form 4, 4, and 4 .., and polarization processing is performed in the thickness direction, and it was shown in the front face and a rear face at drawing 2 , respectively -- like -- etc. -- the slots 3, 3, and 3 which become spacing with passage .., 4 and 4, and 4 .. are formed.

[0009] moreover, the slots 3, 3, and 3 of each side .... and the septa 5, 5, and 5 by which 4, 4, and 4 .. consists of the same ingredient .., 6 and 6, and 6 .. separate -- having -- **** -- respectively -- 1 / 2 pitch ****** -- it is positioned like. slots 3, 3, and 3 ...., 4 and 4,

and 4 .. the end -- nozzle orifices 50, 50, and 50 .. are open for free passage to 1 side-edge 1a of the central substrate 1 so that 51, 51, and 51 .. may be formed, and the other end is made to be open for free passage and make it the ink feed zone material 10 Moreover, in the back end front face of the central substrate 1, it is each slots 3, 3, 3, ..., 4, and 4 and 4.. The circuit pattern 13 which connects the cable 12 connected with the electrode 17 prepared succeeding the wall surface and the base in the drive circuit which is not illustrated is formed.

[0010] As shown in drawing 3 , depth is shallow [the points 3a and 4a used as a nozzle orifice] so that it may become the opening size suitable for making a drop fly, and the center sections 3b and 4b of these slots 3 and 4 are deep so that it may become the volume of extent which can hold the ink of a complement in formation of an ink droplet, and further, the back end side is formed so that it may become opening 10a of the ink feed zone material 10, and the depth which has suitable fluid resistance. the metal layer electrically separated by the null section 15 among the septa 5 and 6 which adjoin the pars basilaris ossis occipitalis and a side attachment wall as each slots 3 and 4 were shown in drawing 4 -- forming -- electrodes 16, 16, and 16 ...., 17 and 17, and 17 .. are prepared and impression of a driving signal is received from a drive circuit.

[0011] With the upper substrate which consists of an ingredient in which the same piezoelectric phenomena as the sign 20 in drawing and a central substrate are shown The slot 21 is formed in the slots 3 and 3 currently formed in the central substrate 1 as shown in drawing 6 , and 3 .... and the location which counters. These slots 21 Point 21a used as a nozzle orifice is shallow, and partial 21b used as an ink room is deep, and it is formed so that back end section 21c may be further open for free passage to opening 10a of the ink feed zone material 10. Each [these] slots 21 and 21 and 21 .... are isolated by septa 22 and 22 and 22 .., and the metal layer electrically separated by the null section 23 is formed in a wall surface and a base, and electrodes 24 and 24 and 24 .. are prepared. These electrodes 24 and 24 and 24 .... form electric conduction relation with the electrodes 16 and 16 of the central substrate 1, and 16 .., when it piles up with the central substrate 1.

[0012] The sign 30 in drawing is the bottom substrate which consists of an ingredient in which the same piezoelectric phenomena as the central substrate 1 are shown. The slot 31 is formed in the slots 4 and 4 currently formed in the central substrate 1 as shown in drawing 9 , and 4 .... and the location which counters. These slots 31 Point 31a used as a nozzle orifice is shallow, and partial 31b which forms an ink room is deep, and back end section 31c is further open for free passage with opening 10a of the ink feed zone material 10. Each [these] slots 31 and 31 and 31 .... are isolated by septa 32 and 32 and 32 .., and the metal layer electrically separated by the null section 33 is formed in a wall surface and a base, and electrodes 34 and 34 and 34 .. are prepared. These electrodes 34 and 34 and 34 .... are the electrodes 17, 17, and 17 of the central substrate 1, when it piles up with the central substrate 1.. ****** relation is formed.

[0013] Drawing 12 shows one example of the processing approach of the central substrate 1 mentioned above, the upper substrate 20, and the bottom substrate 30, fixes the predetermined include angle 41, for example, the wedge-shaped base of 2 times, to the level work-piece standing ways 40, and fixes the piezo electric crystal substrate 42 of predetermined thickness on the surface of this.

[0014] KATTENGU [the location of a dicing saw 43 is set up so that the penetrating

depth in the point which serves as a nozzle orifice in this condition may become the value suitable for a nozzle orifice, for example, 30 micrometers, and / a dicing saw 43 or work-piece immobilization 40th / only fixed distance makes it move horizontally and] relatively. The width of face which is equivalent to the OFF cost of a dicing saw by this at the include angle specified on the wedge-shaped base 41, for example, a 90-micrometer slot, will be formed. An end shape is completed by pulling up a dicing saw 43 slowly, moving horizontally standing ways 40 or a dicing saw 43 still more, when fixed length is cut (I).

[0015] In the phase which formation of one slot ended, the slot of a required number is formed for the work-piece standing ways 40 or a dicing saw 43 predetermined spacing, for example, by being able to shift 170 micrometers and repeating the above-mentioned process again.

[0016] both sides of each piezo electric crystal substrate in which the slot 44 was formed -- technique, such as electroless deposition, and sputtering, vacuum evaporationo, -- a substrate front face -- the nickel layer 45 -- predetermined thickness, for example, 1 micrometer, -- forming -- the front face of (II) and this nickel layer -- a corrosion-resistant metal (Au), for example, gold, -- predetermined thickness -- for example, 0.1 micrometers is formed (III).

[0017] Subsequently, the metal layers 45 and 46 currently formed on the surface of the septum are etched in the direction parallel to passage by cutting or the photolithography with a dicing saw 47 etc., and the deposit of each passage is made to become independent electrically (IV). Thus, each constituted substrate makes each slots 21 and 31 of the upper substrate 20 and the bottom substrate 30 counter each front face, and is fixed by adhesives etc. so that it may be in agreement with the slots 3 and 4 of the central substrate 1. Moreover, open the ink feed zone material 10 and 10 for free passage in the back end section of the upper substrate 20 and the bottom substrate 30, the edges 3a and 4a of the slots 3 and 4 of the central substrate 1 are made to open the ink feed hopper 10a for free passage, and it fixes to a central substrate. Moreover, the slots 31 and 31 of the bottom substrate 30 and 31 .... are made to counter the front face of another side of the central substrate 1, and it is pasted.

[0018] As this showed drawing 13 , arrangement immobilization of the upper substrate 20 and the bottom substrate 30 is carried out so that it may have the directions E2 and E3 of polarization which disagree with the direction E1 of polarization of the central substrate 1 bordering on a connection side with the ******** central substrate 1. the parts 3a and 21a shallowly formed by part for a point, respectively, and 4a and 31a showed each slot currently formed in these substrates 1, 20, and 30 to drawing 14 -- as -- nozzle orifices 50, 50, and 50 ...., 51 and 51, and 51 .. moreover, the ink room of a cross-section length waterdrop mold will be formed in a central part. moreover, the upper substrate 20 and the bottom substrate 30 -- the electrodes 17, 17, and 17 with which each electrode 24, 24, 24, ..., 34 of each, and 34 and 34 are formed in each front face of the central substrate 1 .., 18 and 18, and 18 .. will be contacted and electric conduction relation will be formed.

[0019] thus, the constituted ink jet type recording head was shown in drawing 15 -- as -- each electrodes 24, 24, and 24 of the upper substrate 20 and the central substrate 1 -- it connects with the drive power source 68 through .... and 3 State drive circuits 61-67 in which 17, 17, and 17 .. receives control with the signal from the printing data output

circuit 60. In the ink room 70 corresponding to the location which should form a dot in this condition, one pole, Minus to the electrode prepared in two ink rooms 71 and 72 which adjoin this ink room 70 again For example, the pole of another side, For example, when plus is impressed (drawing 16), the electric fields F1 and F2 which make the ink room 70 an object line, respectively will act on the septa 73 and 74 of the central substrate 1 which has divided the ink room 70 which should form a dot, and the septa 75 and 76 of the upper substrate 20. For this reason, these septa 73, 74, 75, and 76 will curve in shear mode to the ink room 70 side, the volume of the ink room 70 contracts, and the ink which exists here is compressed. The ink of the ink room 70 will fly outside by this from the opening 50 (drawing 13) to which the tip was extracted. Since that cross section is extracted as compared with the ink room 70, this opening 50 will make the ink of an ink room fly in a record form as a drop of the optimal diameter, without performing an operation equivalent to a nozzle, therefore requiring nozzle orifice formation members, such as a nozzle plate, and will form a dot in this.

[0020] If dot formation is completed and impression of a driving signal stops, since the septa 73, 74, 75, and 76 which were deforming now will return to the original condition, ink is supplied to the ink room 70 which an ink room will be expanded in process of this return, therefore formed the ink droplet from ink feed hopper 10a, and preparation of the next dot formation is completed.

[0021] In addition, although it is in the condition that ink is flowing into the ink room in this example and ink is made to breathe out by making the septum which has divided the ink room transform into an ink room side suddenly As shown in drawing 17 , at the time of the direction which expands the volume of the ink rooms 71 and 72 contiguous to the ink room 70, i.e., contraction, it is an opposite direction as a reserve process. And the change rate of field strength impresses the small electric fields F3 and F4, make it transform comparatively slowly the septa 75 and 76 of the upper substrate 20 and the central substrate 1, and 73 and 74, and it fills up the ink room 70 with ink. Make septa 75, 76, 73, and 74 transform into the ink room 70 side rapidly, and an ink droplet is made to breathe out, as shown in drawing 16 . Subsequently, by things An ink droplet can be generated at high effectiveness using the elastic energy which is made filled up with the ink of sufficient amount for the ink room 70, and is accumulated in septa 75, 76, 73, and 74.

[0022] Moreover, although a slot is formed in both sides of the central substrate 1 in an above-mentioned example and he is trying to form the nozzle orifice of two trains, even if it constitutes what formed the slot only in one field of the substrate equivalent to an above-mentioned central substrate, and was equipped with the nozzle orifice of only one train, it is clear to do the same operation so.

[0023] Drawing 18 (a) and (b) are drawings showing the structure of the piezo electric crystal substrate which constitutes other ink jet type recording heads of this invention, respectively, the sign 80 in drawing is a piezo electric crystal substrate, it consists of an ingredient in which piezoelectric phenomena, such as lead zirconate, are shown, and polarization processing is performed in the thickness direction, and the slots 81 and 81 which serve as passage at equal intervals, and 81 .... are formed in the front face.

[0024] the septa 82, 82, and 82 by which each slots 81 and 81 and 81 .... consist of the same ingredient -- it is formed so that .... may dissociate, it may be open for free passage to 1 side-edge 80a of a substrate 80 so that the end may form a nozzle orifice, and the

other end may be open for free passage to an ink feed hopper. The point from which these slots 81 and 81 and 81 .... become a nozzle orifice like the above-mentioned example has shallow depth so that it may become the opening size suitable for making a drop fly, and a center section is deep so that it may become the volume of extent which can hold the ink of a complement in formation of an ink droplet, and further, the back end side is formed so that it may become opening of ink feed zone material, and the depth which has suitable fluid resistance. further -- each slots 81, 81, and 81 -- electrodes 84 and 85 are formed in a pars basilaris ossis occipitalis and a side attachment wall so that it may be made the longitudinal direction by the null section 83 for 2 minutes, and external connection of these electrodes 84 and 85 is enabled with the electric conduction patterns 86 and 87 at ...., respectively.

[0025] Moreover, the substrate 90 (this drawing (b)) of another side which makes this and a pair consists of the same piezoelectric material as the above-mentioned, and a slot 91 and electrodes 94 and 95 are formed so that it may be aimed at a plane of composition on the surface of this. namely, the septa 92, 92, and 92 by which the slots 91 and 91 which serve as passage at equal intervals, and 91 .... are formed in the front face of the piezo electric crystal substrate 90, and each [these] slots 91 and 91 and 91 .. consist of the same ingredient .... dissociates. These slots 91 and 91 and 91 .... are formed so that it is open for free passage to 1 side-edge 90a of a substrate 90 so that an end may form a nozzle orifice, and the other end may be open for free passage to an ink feed hopper. The point from which slots 91 and 91 and 91 .... become a nozzle orifice like the above-mentioned example has shallow depth so that it may become the opening size suitable for making a drop fly, and a center section is deep so that it may become the volume of extent which can hold the ink of a complement in formation of an ink droplet, and further, the back end side is formed so that it may become opening of ink feed zone material, and the depth which has suitable fluid resistance. Furthermore, electrodes 94 and 95 are formed in the pars basilaris ossis occipitalis and the side attachment wall so that each slots 91 and 91 and 91 .... may be made into the longitudinal direction by the null section 93 for 2 minutes. External connection of these electrodes 94 and 95 is enabled with the electric conduction patterns 96 and 97, respectively.

[0026] Thus, when two constituted piezo electric crystal substrates 80 and 90 are made to counter and it is made to rival with adhesives etc., two substrates 80 and 90 will have the ink room of the cross-section length waterdrop mold which has the nozzle orifice extracted from the part in which it had polarization polarity E4 and E5 in the direction which conflicts bordering on the connection side, and a part for a point was formed shallowly, respectively. Moreover, two electrodes 84 and 85 formed in each slot 81 of a substrate 80 and two electrodes 94 and 95 of a substrate 90 will contact mutually, and will form electric conduction relation, and the electrode divided into two at the longitudinal direction will be formed in one ink room.

[0027] Drawing 19 shows the drive method of the recording head mentioned above, and outputs the time amount taken for vibration to spread the output of 3 State drive circuits 101 which receive control with the signal from the printing data output circuit 100 to the electrodes 85 and 95 by the side of the ink feed hopper 103, and to spread inter-electrode [these] to the electrodes 84 and 94 by the side of direct and a nozzle through the delay circuit 102 made into a time delay.

[0028] According to this example, if a driving signal is impressed, since a signal is first

impressed to the electrodes 85 and 95 by the side of the ink feed hopper 103, among the septa 82 and 92 which constitute passage, only the field of electrodes 85 and 95 deforms into an ink room side, the ink which exists here will be compressed and an elastic wave will be produced. If the time amount (20 microseconds when [For example,] the center distance of the electrode currently divided is 20mm) set as the delay circuit 102 passes, the elastic wave from electrodes 85 and 95 will reach electrodes 84 and 94. At this time, a signal will output from a delay circuit 102, and a driving signal will be impressed to electrodes 84 and 94. For this reason, since ink will be further compressed by the electrode 84 and the septa 82 and 92 of 94 fields with the gestalt superimposed on the elastic wave generated with electrodes 85 and 95, are high effectiveness, moreover, the ink which goes to a nozzle orifice will be compressed in a short field, a sharp pressure wave is made to act on a nozzle orifice, and the good ink droplet of an ink piece is made to fly.

[0029] In addition, even if it makes it impress a driving signal to the electrode which divided or more into three at the longitudinal direction, and was each divided while delaying only the time amount required for the pressure wave generated in the ink feed hopper side to reach each electrode although he is trying to divide an electrode into two in this example at the longitudinal direction of a slot, it is clear to do the same operation so.

[0030] The structure of the electrode of an ink jet recording head of making other examples of this invention shows drawing 20 , as mentioned above here, the slot 111 which is open for free passage to end 110a of the piezo electric crystal substrate 110, and forms a nozzle orifice is formed, the sign 110 in drawing is a piezo electric crystal substrate, and the electrode 112,112 for making electric field act on a septum is formed in the wall surface of a slot 111, and the base. This electrode 112,112 consists of field 112a which becomes the side which serves as a nozzle orifice, i.e., substrate edge 110a, and field 112b which becomes an ink feed hopper side so that field 112b by the side of an ink feed hopper may become thick. Needless to say, the electrode with which such thickness differs partially can be simply formed by controlling vacuum evaporationo time amount and plating time amount.

[0031] If such electrode structure is taken, since the elasticity of the septum by the side of an ink feed hopper can be reinforced with a metal with a bigger elastic modulus than a piezo electric crystal substrate, deformation of the septum of an ink feed hopper side field will start earlier than a nozzle orifice side. Since it is in the condition in the middle of the septum of this field being deformation when the pressure wave of the ink produced according to this deformation reaches a nozzle orifice side, the pressure wave spread from the ink feed hopper side will be compressed further, a sharp pressure wave is made to act on a nozzle orifice like the above-mentioned, and the good ink droplet of an ink piece is made to fly.

[0032] In addition, although he is trying to change the thickness of the metal layer which constitutes an electrode in this example to the longitudinal direction of a slot in two steps Partial 122a which carried out the increment of the thickness to the longitudinal direction of the slot 121 of the piezo electric crystal substrate 120 more than the three-stage as shown in drawing 20 (a), As shown in drawing 20 (b), even if it forms the electrode 122 with 122b and 122c or an ink supply side forms the electrode 123 which becomes thick in monotone, it is clear to do the same operation so.

[0033] The structure of the slot which forms in a piezo electric crystal substrate other examples on which a pressure wave is centralized shows drawing 22 , the sign 130 in drawing is the slot formed in the piezo electric crystal substrate 131, field 130b shallow to extent to which deep field 130a does not cause a failure to an ink feed hopper side again at ink droplet formation is formed in a nozzle orifice side, and the electrode 132 is formed in these wall surfaces and a base. According to this example, as compared with the height H2 by the side of a nozzle orifice, since it is small, as for the septum 133 which deforms with the driving signal impressed to the electrode 132, the height H1 by the side of an ink feed hopper will have a high elastic modulus in response to constraint at the bottom. Consequently, when a driving signal is impressed to an electrode, an ink feed hopper side deforms first, and since a nozzle orifice side with a small elastic modulus will deform continuously, the septum of a nozzle orifice side field will deform with the gestalt superimposed on the pressure wave spread from the ink feed hopper side. Therefore, a sharp pressure wave can be made to act on a nozzle orifice like the above-mentioned example.

[0034] As shown in drawing 23 according to the example shown in drawing 19 **** drawing 22 mentioned above, it is a time of the pressure wave (this drawing I) generated in the ink feed hopper side setting time amount deltaT, and arriving at a nozzle orifice side (this drawing II), and since the field here can be made to transform, it becomes possible to make a nozzle orifice spread a small pressure wave with big peak value of the skirt as shown with the dotted line in this drawing. Consequently, the ink droplet which a regurgitation rate is quick, the short ink droplet of duration will moreover occur, and whose knee is small, and moreover does not have generating of tailing can be injected in a record form (this drawing III).

[0035] On the other hand, since a pressure wave occurs in coincidence in all the fields from a nozzle orifice to an ink feed hopper as shown in drawing 24 (I) and this spreads to a nozzle orifice one by one in not taking the above measures, it will elutriate over comparatively long time amount like the liquid jet from a water gun exactly. For this reason, the ink droplet which this drawing (II) flying speed is small, and moreover carries out long duration continuation will occur, a knee and a satellite will be produced, and deterioration of a quality of printed character will be caused.

[0036] By drawing 25 showing the 2nd example of this invention, the sign 140 in drawing is the substrate which consists of piezoelectric material, such as lead zirconate, and it is selected by the depth of the deepest part of the passage mentioned later, for example, bigger thickness than 1/2 [400-micrometer], for example, 1mm, and polarization processing is beforehand made in the thickness direction. 141 is the upper substrate which consists of the same ingredient as the above-mentioned substrate 140, it is selected by the thickness with about 1/comparable as 2 of the deepest part of passage, for example, 200 micrometers, and polarization processing is beforehand made in the thickness direction. It is fixed with adhesives and these substrates 140,141 are constituted by one substrate 142 so that the direction of polarization may counter.

[0037] Slot 143,143,143 .... which constitutes passage as were shown in drawing 26 and this substrate 142 uses the substrate 141 with thinner thickness as a front face is formed. At the end of a substrate 142, these slots so that a nozzle orifice may be formed united with the lid 150 later mentioned as width of face was chosen as 85 micrometers and it was shown in drawing 27 With a very shallow depth of 80 micrometers, for example,

depth, partial 143a, It is formed so that it may become the shallow depth with which passage is severed by the wall surface as partial 143b and the other end with a thickness [twice / about / the depth of a substrate 141] and a depth of 400 micrometers are a substrate 141, for example, partial 143c which is 100 micrometers. There is little this partial 143c about the return of ink at the time of opening 151a of the ink feed zone material 151 mentioned later, and fixed fluid resistance, i.e., printing, and at the time of ink supply, that depth and die length are chosen so that it may become extent with which ink flows into whether you are Sumiya.

[0038] Septum 146,146,146 .. which consists of the same ingredient, respectively dissociates, and a metal layer is prepared in the wall surface and a base, electrode 147,147,147 .. is constituted, electric conduction pattern 148,148,148 .. connects with a cable 149, and each slot 143,143,143 .... receives a driving signal from an external drive circuit.

[0039] It returns to drawing 25 again, and 150 is the lid mentioned above, and it is being fixed to the substrate 142 so that from point 143a of the slot 143,143,143 formed in the substrate 142 to back end section 143c may be sealed. 151 is ink feed zone material and is attached in a part of back end section 143c of the ink feed hopper 151a fang furrow 143, and a location open for free passage. Drawing 28 shows one example of the formation approach of the slot 143 mentioned above, and the sign 155 in drawing is the substrate which made the direction of polarization counter, and two piezo electric crystal substrates 156,157 with which polarization processing was made beforehand were made to rival, and constituted them, and is fixed to the bench by making the substrate 156 of the thinner one into a cutting initiation side. A dicing saw 160 is set to the location used as the central part of a slot in this condition, and the slot 161 of the die length which was made to move infeed, a dicing saw, and a substrate 155 relatively, and was suitable for the ink room is formed until it becomes about 2 times of the thickness of a substrate (I).

[0040] A dicing saw 160 is pulled up in the phase in which the slot 161 which does in this way and serves as an ink room in ** was formed, a dicing saw 160 is moved at the tip of a substrate 155, and this part is deeply cut by predetermined Mr. Fukashi (II). Furthermore, a dicing saw 160 is moved to another side of a substrate 155, and the part used as a connection with ink feed hopper 151a is formed. At this time, infeed depth and die length are adjusted according to ink and the ink supply pressure to be used. In the phase which formation of a slot ended, the layer of a nickel chromium alloy is formed by vacuum evaporationo, sputtering, electroless deposition, etc. so that it may become 4 micrometers in thickness, and a golden (Au) layer is formed in the front face of this layer so that it may become 1 micrometer in thickness. Thus, when a metal layer is formed all over the front face of a substrate, the wall surface of a slot, and a base, the metal layer on the top face of a septum which has divided the slot is removed, and the electrode for every slot is separated electrically. The metal layer of the front face of the substrate back end section is made to correspond to an electrode that the track connected to these electrodes according to this should be formed, and it dissociates.

[0041] If the cross-section structure of the ink jet type recording head constituted by carrying out drawing 29 in this way is shown and ink is supplied to ink feed hopper 151a in this example, ink will flow into the whole slot from edge 143c of a slot 143, and will form a meniscus in a nozzle orifice 145. the electrode of the slot which is open for free passage in this condition to the nozzle orifice in which a dot should be made to form --

one pole -- moreover, if the electrical potential difference of the pole of another side is impressed to the electrode of two slots which adjoin this, the septum which has divided the slot which should form a dot as mentioned above will deform in shear mode, and will reduce the volume here to an ink room side. Ink will fly outside by this from the nozzle orifice 145 formed with point 143a of the slot on the substrate, and a lid 150. If a signal is severed when formation of a dot is completed, since a septum will be in the original condition, the volume of a slot is expanded, ink is supplied from edge 143c of a slot by this, and it prepares for the next printing.

[0042] In addition, although an ink room is reduced by impression of a driving signal in this example and he is trying to print, after making an ink room extend as drawing 17 explained, it can also print. Moreover, the technique shown in drawing 18 (a) **** drawing 22 (b) also in this example, That is, an electrode is divided into a nozzle orifice and ink supply side to at least two fields. According to the propagation velocity of a pressure wave, time difference is given from an ink supply side. Impress a driving signal or Moreover, by applying forming in an ink supply side the electrode which becomes thick one by one from a nozzle orifice side, and making shallow the depth of flute by the side of ink supply, and making small relatively the elastic modulus by the side of a nozzle orifice It is clear that Susono generates a pressure wave with big peak value, and can generate the sharp ink droplet of an ink piece small.

[0043] Drawing 30 shows one example of this invention, the sign 170 in drawing is the substrate which consists of piezoelectric material, such as lead zirconate, it is selected by the deepest partial depth of the passage mentioned later, for example, bigger thickness than 1/2 [400-micrometer], for example, 1mm, and polarization processing is beforehand made in the thickness direction. 171 is the upper substrate which consists of the same ingredient as the above-mentioned substrate 170, it is selected by the thickness with about 1/comparable as 2 of the deepest part of passage, for example, 200 micrometers, and polarization processing is beforehand made in the thickness direction. It is fixed with adhesives and these substrates 170,171 are formed in one plate so that the direction of polarization may counter. As the slot 173 with a width of face of about 85 micrometers mentioned above so that the substrate 171 with thinner thickness might serve as an effective area, it is formed at constant pitch and is in this substrate 172. These slots 171 are formed so that it may become the depth of about 400 micrometers of about 2 twice of the thickness of a substrate 171, for example, the depth, with cross-section boat form, a metal layer is prepared in the wall surface and base the same with having mentioned above, and the electrode 176 is formed.

[0044] It has the die length of extent which 180 is a lid, an end is wide opened at the edge as shown in drawing 31 , and the other end opens for free passage into the slot 173 of the piezo electric crystal substrate 171 at least. And the depth, size suitable for both width of face forming the nozzle orifice which makes an ink droplet fly, For example, it is constituted so that about 80 micrometers slot 180a may be formed according to the pitch of a slot 173,173,173 and may form a nozzle orifice 181 (drawing 32) in a point by slot 180a of a lid 180, and the front face of the piezo electric crystal substrate 171. 182 is ink feed zone material, and it is being fixed so that it may be open for free passage by the other end of the ink feed hopper 182a fang furrow 173.

[0045] In this example, if a driving signal is impressed to the electrode 176 of two slots contiguous to the slot which is open for free passage to the nozzle orifice which should

form a dot the same with having mentioned above, a septum will deform and an ink room will contract. A pressure is received, and the ink held in the slot by this serves as an ink droplet from the nozzle orifice 181 formed by level difference 180a of a lid 180, and the piezo electric crystal substrate 172, and will fly. In addition, although an ink room is reduced by impression of a driving signal in this example and he is trying to print, after making an ink room extend as drawing 17 explained, it can also print.

[0046] Moreover, the technique shown in drawing 18 (a) **** drawing 22 (b) also in this example, That is, an electrode is divided into a nozzle orifice and ink supply side to at least two fields. According to the propagation velocity of a pressure wave, time difference is given from an ink supply side. Impress a driving signal or Moreover, by applying forming in an ink supply side the electrode which becomes thick one by one from a nozzle orifice side, and making shallow the depth of flute by the side of ink supply, and making small relatively the elastic modulus by the side of a nozzle orifice It is clear that Susono generates a pressure wave with big peak value, and can generate the sharp ink droplet of an ink piece small.

[0047] It is what is shown that drawing 33 is also at the structure of a slot about other examples of this invention. The sign 190 in drawing polarization processing should do in the thickness direction -- about [of the maximum depth of the slot which one thickness should form] -- with the piezo electric crystal substrate 191 which has one half of thickness, and the substrate which made the direction of polarization counter, and the thicker piezo electric crystal substrate 192 was made to rival, and consisted of this substrate 191 From the side used as a nozzle orifice, the slot is formed so that depth may become deep in monotone at an ink supply side at the shape of a straight line.

[0048] According to this example, a dicing saw is applied to the side used as the nozzle orifice of a substrate 190, and it becomes possible to form a slot by one actuation only by performing cutting, bringing a dicing saw and a substrate 190 in the direction which should form a slot close relatively. In addition, although the case where a nozzle orifice was formed only in one field of a substrate in the example shown in drawing 25 and drawing 30 was taken and explained to the example, the gestalt of 2 train array as shown in drawing 1 can also be taken.

[0049] That is, as shown in drawing 34 , the piezo electric crystal substrate 201,202 equipped with about 1/2 thickness of the slot which should be formed in both sides of the piezo electric crystal substrate 200 arranged in the center is stuck, and a slot 203,204 is formed in a predetermined pitch from these piezo electric crystal substrate 201,202 side, respectively. If close with a lid 205,206, the slot 203,204 of each field is made open for free passage and the ink feed zone material 207,208 is formed while forming in these slots 203,204 the electrode which became independent electrically, respectively, the recording head equipped with the nozzle orifice of two trains can be constituted easily.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the perspective view showing the 1st example of the ink jet type recording head of this invention.

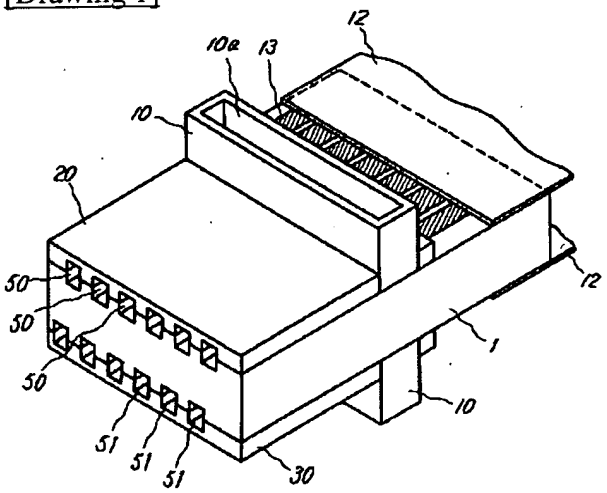
[Drawing 2] It is the perspective view showing one example of the piezo electric crystal substrate arranged in the center.

[Drawing 3] It is the sectional view showing the configuration of the slot currently formed in the piezo electric crystal substrate arranged in the center.
[Drawing 4] It is the perspective view showing the structure of an electrode prepared in the piezo electric crystal substrate arranged in the center.
[Drawing 5] It is drawing showing the electrode structure of the piezo electric crystal substrate arranged in the center.
[Drawing 6] It is the perspective view showing the structure of the piezo electric crystal substrate which are used by making it the piezo electric crystal substrate and pair which are arranged in the center.
[Drawing 7] It is drawing showing the cross-section structure of the slot currently formed in the above-mentioned substrate.
[Drawing 8] It is drawing showing the electrode structure of a piezo electric crystal substrate.
[Drawing 9] It is the perspective view showing the structure of other piezo electric crystal substrates which are used by making it the piezo electric crystal substrate and pair which are arranged in the center.
[Drawing 10] It is drawing showing the cross-section structure of the slot currently formed in the above-mentioned substrate.
[Drawing 11] It is drawing showing the cross-section structure of the electrode currently formed in the above-mentioned substrate.
[Drawing 12] This drawing (I) - (IV) are drawings showing the process which forms a slot, and the process which forms an electrode in a piezo electric crystal substrate, respectively.
[Drawing 13] It is the sectional view showing the structure of the 1st ink jet type recording head of this invention.
[Drawing 14] It is drawing which looked at the 1st ink jet type recording head of this invention from the ink droplet injection side.
[Drawing 15] It is drawing showing the drive method of the ink jet type recording head of this invention.
[Drawing 16] It is drawing showing the deformation condition of the septum at the time of expulsion of an ink droplet.
[Drawing 17] It is the explanatory view showing other drive methods of the ink jet type recording head of this invention.
[Drawing 18] This drawing Fig. (b) and (b) are the perspective views showing other examples of electrode structure, respectively.
[Drawing 19] Drawing is drawing showing the drive method suitable for the recording head which takes the electrode structure shown in drawing 18 .
[Drawing 20] This drawing (b) and (b) show other examples of electrode structure, respectively, and drawing (b) shows the structure as which drawing (b) regarded cross-section structure from the opening side of a slot again.
[Drawing 21] This drawing (b) and (b) are drawings showing other examples of electrode structure in the condition of having seen from the opening side of a slot, respectively.
[Drawing 22] This drawing Fig. (b) and (b) show other examples of the slot formed in a piezo electric crystal substrate, respectively, and drawing (b) is the plan as which drawing (b) regarded the sectional view from the opening side of a slot again.
[Drawing 23] It is drawing showing the condition of the pressure wave of the ink at the

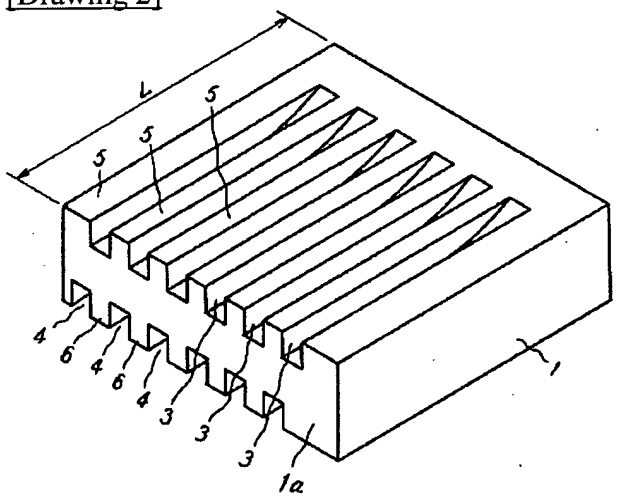
time of taking the electrode structure shown in drawing 18 **** drawing 22 , and the structure of a slot, and the gestalt of an ink droplet brought about by this.
[Drawing 24] When not taking the measures shown in drawing 18 **** drawing 22 , it is drawing showing the condition of the pressure wave produced in ink, and the gestalt of an ink droplet brought about by this.
[Drawing 25] It is the perspective view showing the 2nd example of this invention.
[Drawing 26] It is the perspective view showing the structure of the piezo electric crystal substrate used for the ink jet recording head shown in the 2nd example.
[Drawing 27] It is the sectional view showing the configuration of the slot formed in a piezo electric crystal substrate same as the above.
[Drawing 28] This drawing (I), (II), and (III) are drawings showing the technique of forming a slot in a piezo electric crystal substrate, respectively.
[Drawing 29] It is drawing showing the cross-section structure of the equipment shown in drawing 25 .
[Drawing 30] It is the sectional view showing the 3rd example of this invention.
[Drawing 31] It is the perspective view showing one example of the covering device material used for drawing 30 .
[Drawing 32] It is the front view showing the structure by the side of the nozzle orifice in a recording head same as the above.
[Drawing 33] It is the sectional view of the piezo electric crystal substrate it is indicated that is also at the structure of a slot about the 4th example of this invention.
[Drawing 34] It is the sectional view showing the physical relationship of the piezo electric crystal substrate in the case of making the nozzle train in the 2nd ****** 4 above-mentioned example into dual structure, and a lid, and the structure of the slot formed in a piezo electric crystal substrate.
[Description of Notations]
1, 20, 30 Piezo electric crystal substrate
3 Four Slot
5 Six Septum
10 Ink Feed Zone Material
17, 24, 18, 34 Electrode
50 51 Nozzle orifice

DRAWINGS

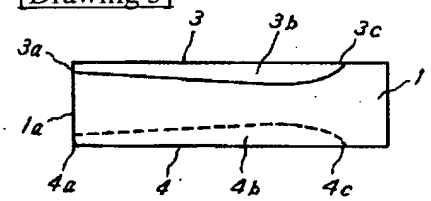
[Drawing 1]



[Drawing 2]



[Drawing 3]



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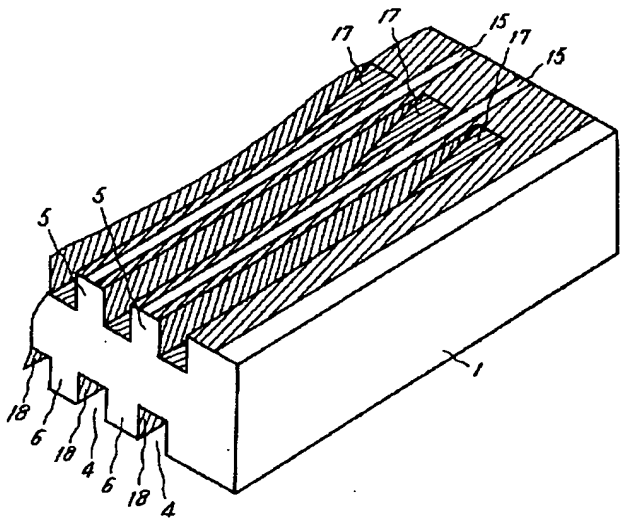

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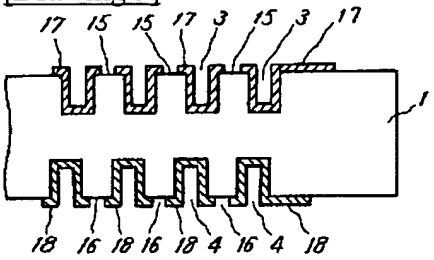

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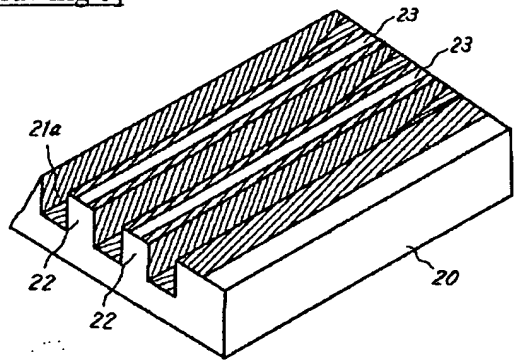
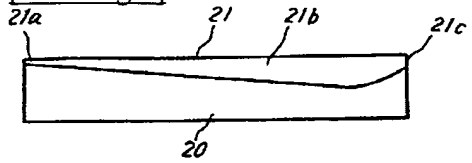
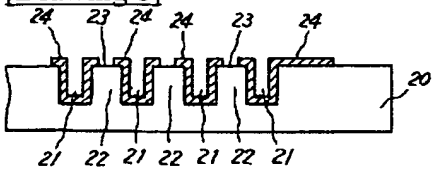


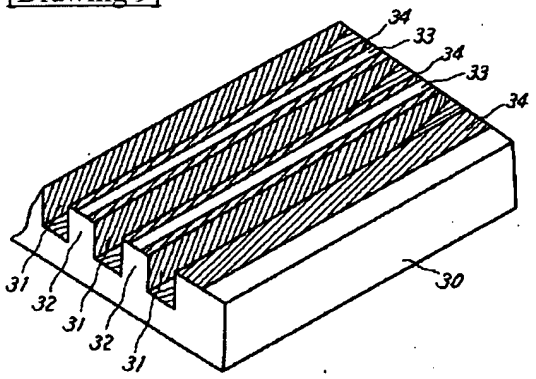
[Drawing 7]



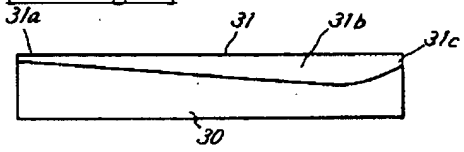
[Drawing 8]



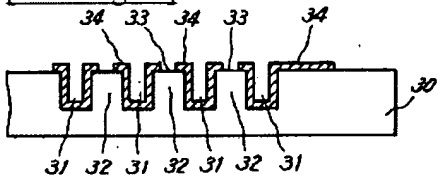
[Drawing 9]



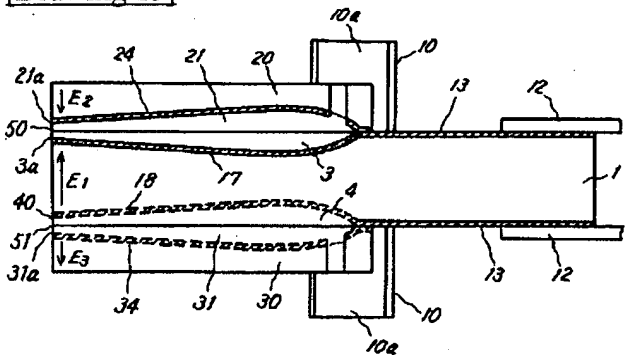
[Drawing 10]



[Drawing 11]



[Drawing 13]



[Drawing 12]

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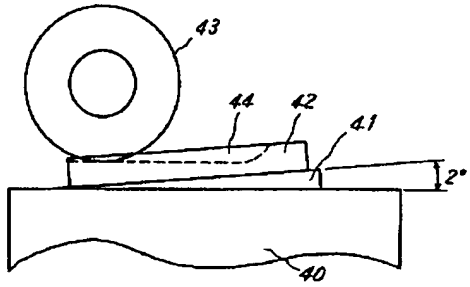

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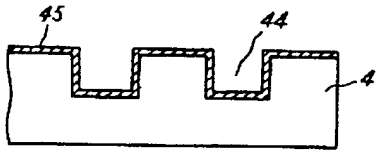

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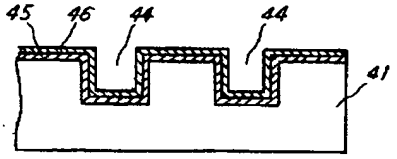

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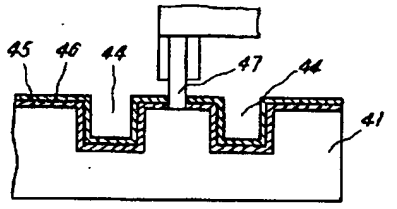
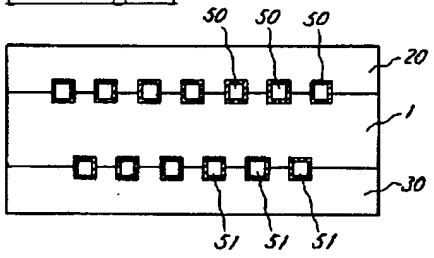


[Drawing 14]



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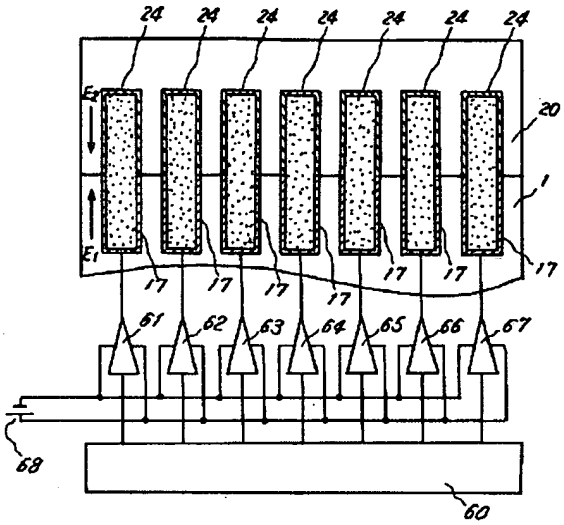
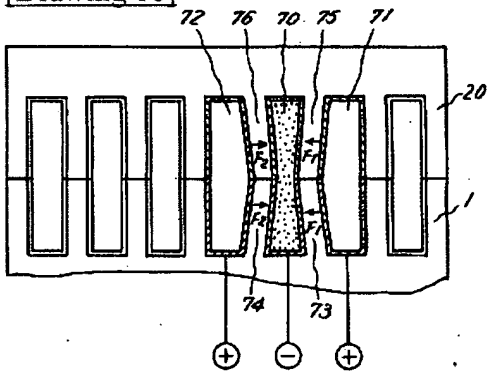
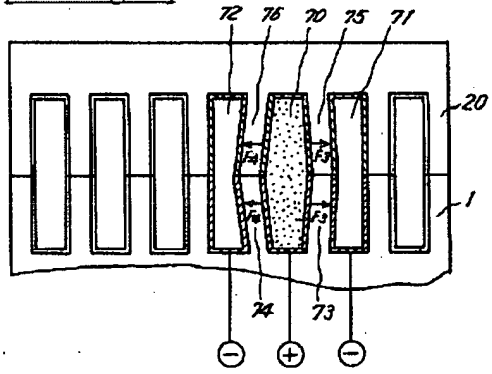


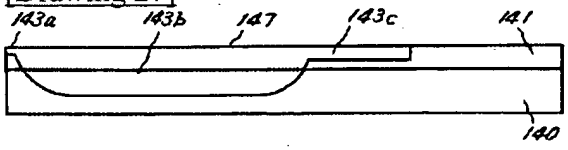
[Drawing 16]



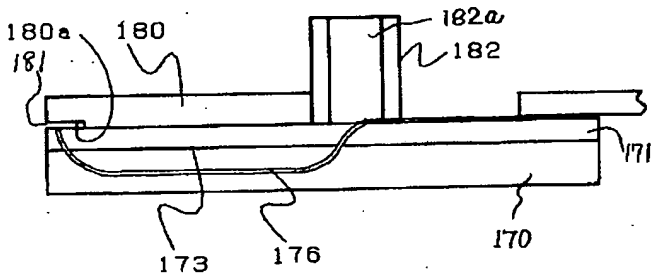
[Drawing 17]



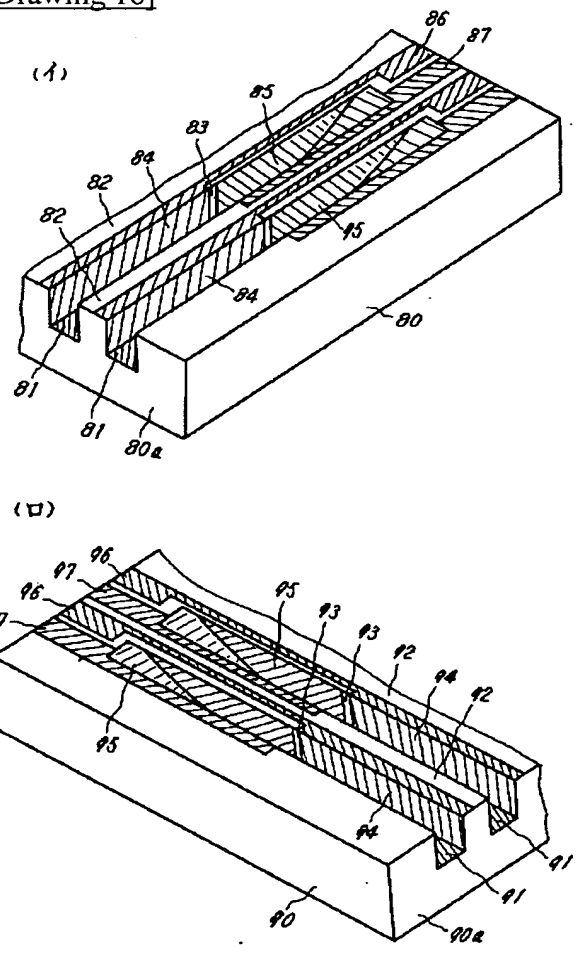
[Drawing 27]



[Drawing 30]



[Drawing 18]



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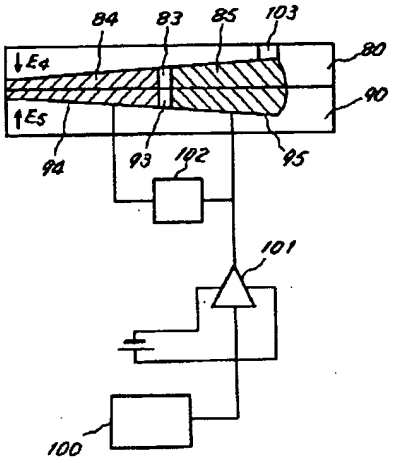
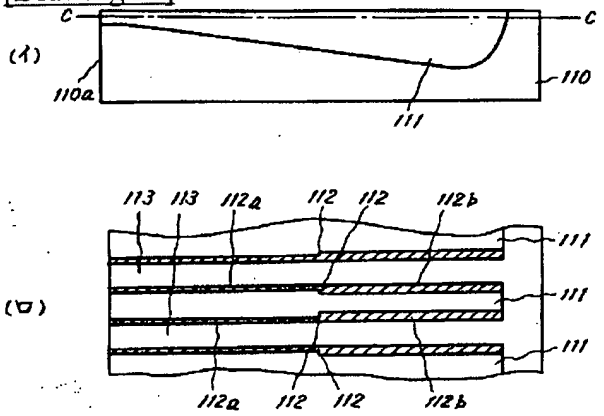


[Drawing 20]



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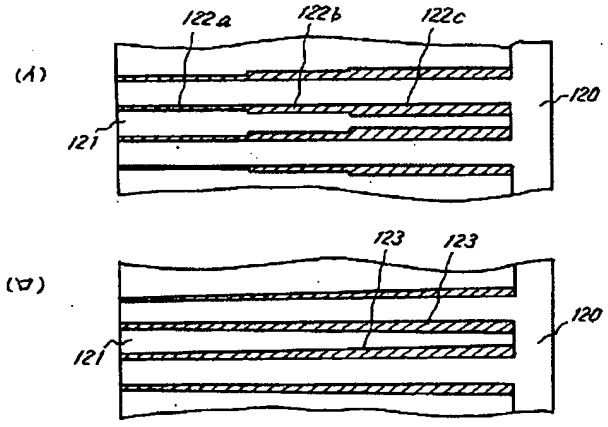
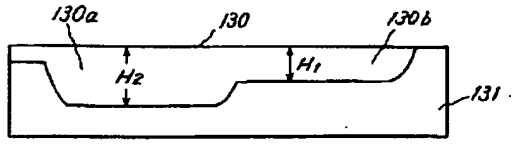


[Drawing 22]

(イ)



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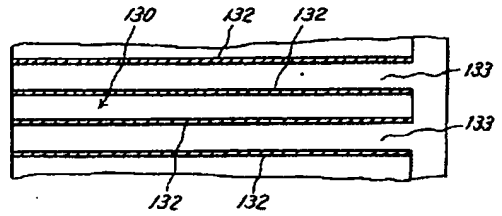
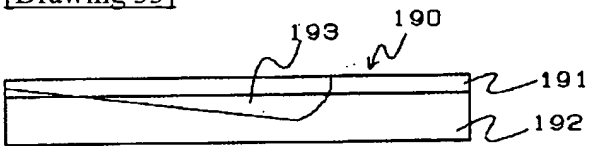
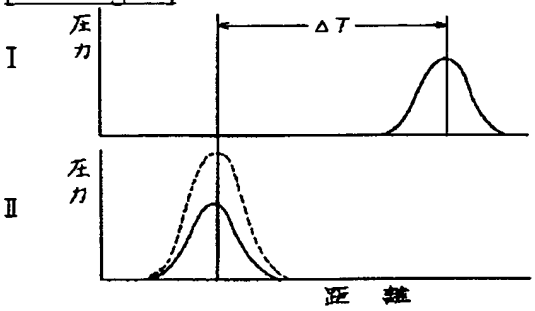


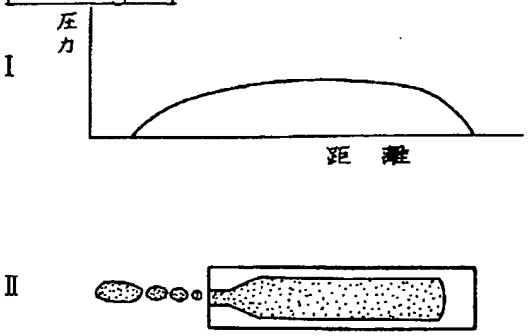
[Drawing 33]



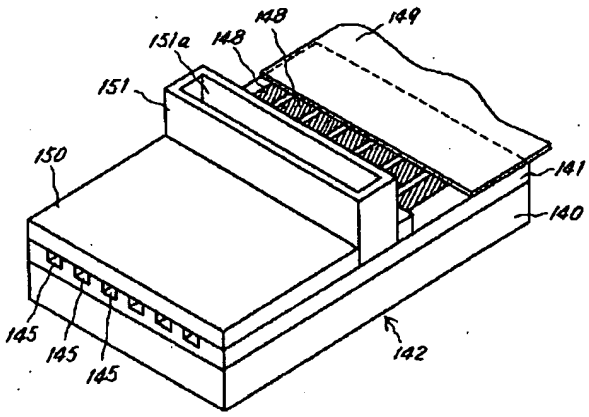
[Drawing 23]



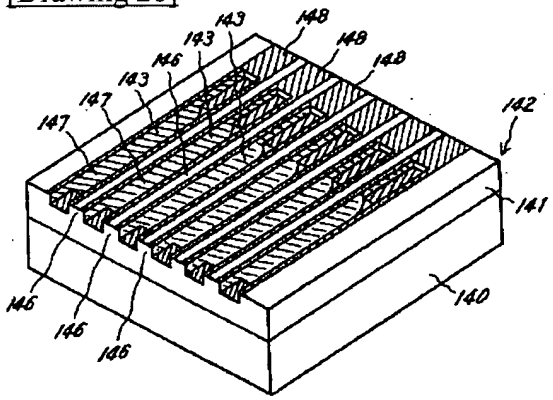
[Drawing 24]



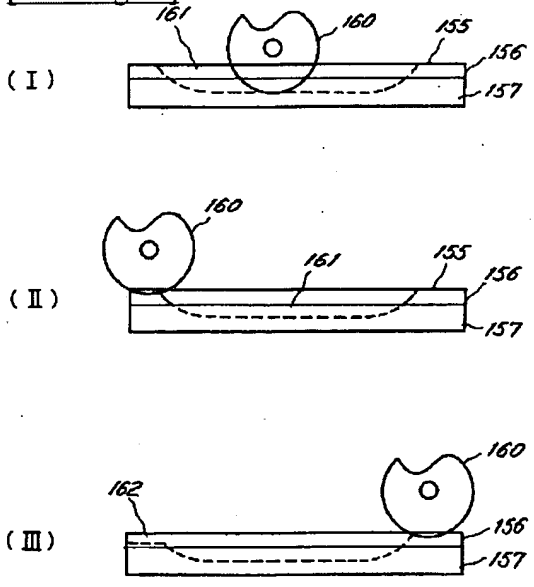
[Drawing 25]



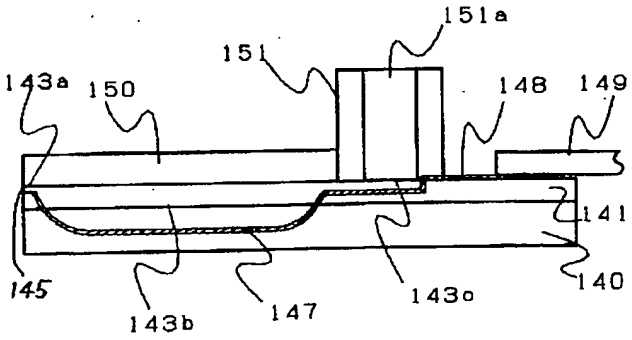
[Drawing 26]



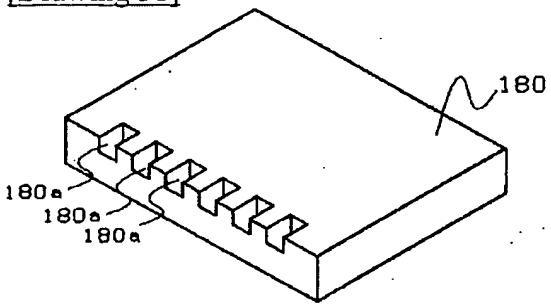
[Drawing 28]



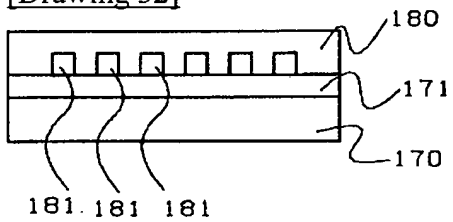
[Drawing 29]



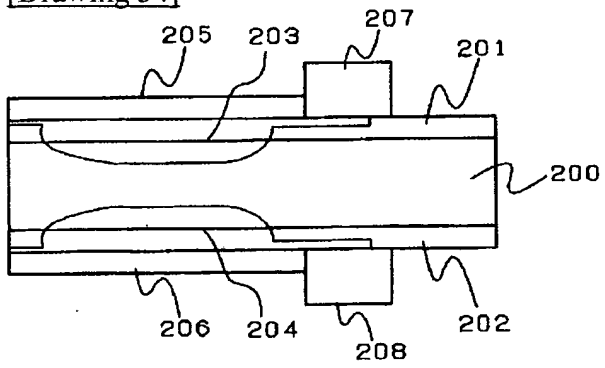
[Drawing 31]



[Drawing 32]



[Drawing 34]



[Translation done.]